Scott River Watershed Restoration Strategy & Schedule

Prepared by

the Scott River Watershed Council

&

Siskiyou RCD

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I. Purpose, and Objectives

Purpose Statement

The purpose of this "*Strategy & Schedule*" is to assess all existing information (both local information and peer-reviewed literature) regarding the status of the Scott River riparian corridor and previous revegetation efforts, and, where appropriate, to develop a plan for riparian protection, enhancement and restoration of the Scott River mainstem & tributaries. The intent of the "*Strategy & Schedule*" is to identify the most appropriate locations and restoration methods to enhance the river ecosystem to benefit the wildlife and aquatic health of the Scott River. Methods identified in this document are evidence-based and rely on methods proven to work in the Scott River Watershed or in other similar watersheds. In addition, this plan will outline methods to meet the intentions of the Scott River TMDL, to the fullest extent possible.

This document is intended to provide the local community with a tool to leverage funding for high priority restoration locations, as well as document the extent of riparian restoration implemented to date. An additional purpose is to identify the limitation to riparian restoration on the Scott River, given the current hydrologic, economic, and permitting restraints.

The benefits of riparian revegetation will include improved water quality, increased bank stability, increased terrestrial and aquatic habitat and food chain support for aquatic and terrestrial species. An additional benefit is increased water storage.

Objectives

The objectives of this plan are to: identify locations in the Scott River and tributaries most likely to benefit to riparian restoration measures, identify specific methods most appropriate for watershed restoration in the Scott Valley, identify reach specific design criteria, identify and prioritize project areas (including identification of willing landowners), develop a proposed schedule for restoration, and identify potential funding sources.

II. Introduction

Benefit/value of Riparian Vegetation

A riparian area is defined as the interface between land and a river or stream. The stream channel and banks are riparian areas, and the plants that grow there are called riparian vegetation. Riparian vegetation is essential for maintaining high water quality in streams, rivers, lakes, and along shorelines. Riparian zones dissipate stream energy, slow down water and prevent soil erosion. The meandering curves of a river, combined with vegetation and root systems, dissipate stream energy, which results in less soil erosion and a reduction in flood damage. Sediment is trapped, reducing suspended solids to create less turbid water, replenish soils, and build stream banks. Pollutants are filtered from surface runoff which enhances water quality via biofiltration (use of living material to capture and biologically degrade process pollutants)

The riparian zones also provide wildlife habitat, increase biodiversity, and provide wildlife corridors, enabling aquatic and riparian organisms to move along river systems avoiding isolated communities. They can provide forage for wildlife and livestock. Specific functions and benefits of riparian zones include:

- Bank stabilization and water quality protection
- Food chain support
- Thermal cover
- Fish habitat
- Wildlife habitat

Each of these benefits is described below:

- ***Bank stabilization and water quality protection***

The roots of riparian trees and shrubs help hold streambanks in place, preventing erosion. Riparian vegetation also traps sediment and pollutants, helping keep the water clean. Four specific ways vegetation can protect streambanks are (Klingeman and Bradley 1976):

I. The root system helps to hold the soil together and increases the overall bank stability by the ability of roots to hold soil particles together.

II. The exposed vegetation (stems, branches, and foliage) increases the resistance to flow and reduces the local flow velocity, causing the flow to dissipate energy against the plant parts rather than the soil.

III. The vegetation acts as a buffer against the abrasive effect of transported materials.

IV. Close-growing vegetation can induce sediment deposition by causing zones of slow velocity allowing sediments to deposit.

Vegetation is normally less expensive than most structural methods; it improves the conditions for fisheries and wildlife, improves water quality, and can protect cultural/archeological resources.

- ***Food chain support***

Salmon and trout, during the freshwater stage of their life cycle, eat mainly aquatic insects. Aquatic insects spend most of their life in water. They feed on leaves and woody material such as logs, stumps and branches that fall into the water from streambanks. Standing riparian vegetation is habitat for other insects that sometimes drop into the water, providing another food source for fish.

- ***Thermal cover***

Riparian vegetation shields streams and rivers from summer and winter temperature extremes that may be very stressful, or even fatal, to fish and other aquatic life. The cover of leaves and branches brings welcome shade, ensuring that the stream temperature remains cool in the summer and moderate in the winter.

- ***Fish habitat***

As dying or uprooted trees fall into the stream, their trunks, root wads, and branches slow the flow of water. Large snags create fish habitat by forming pools and riffles in the stream. Riffles are shallow gravelly sections of the stream where water runs faster. Many of the aquatic insects that salmon eat live in riffles. Salmon also require riffles for spawning. They use pools for resting, rearing and refuge from summer drought and winter cold.

- ***Wildlife habitat***

Riparian vegetation provides food, nesting, and hiding places for various animals and birds, including migratory birds.

Currently the tributaries to the Scott River, and portions of the Scott River Mainstem support a variety of wildlife and fisheries habitat. Deer, elk, beaver, and a variety of birds rely on these riparian areas, especially the corridor between French Creek and the mainstem Scott River. This document intends to identify a method to expand those habitats and riparian corridors.

III. Background

The Scott River and tributaries have been significantly altered in the past one hundred and fifty years. Large scale channel alterations (levying, dredging, straightening) have impacted the channel geomorphology and hydrological function of the Scott River. Extensive efforts have been undertaken in the past 20 years to attempt to restore the Scott River to a healthier riparian function. To date these efforts have been most successful in the South end of the Watershed (Siskiyou RCD 2009). Howeverin some locations of the Scott River Watershed it may be economically, hydrologically, and culturally impossible to return sections of the Scott River and tributaries to its historic potential vegetation conditions.

While the following paragraph gives a summary of the condition of the Scott River prior to European settlement, it should be recognized that many economic and legal situations exist that prevent fully returning the Scott River to its pre-European condition. In addition, any future significant flood event, such as the 1964 flood, or 1997 has the potential to remove much of the recent progress in re-vegetation. In addition to flooding, periods of extended drought impact the success of riparian revegetation projects.

Historic documents show the Scott Valley floor as having many beaver ponds, and grassy prairies. These beaver ponds would have backed up water and provided habitat for juvenile fish. The backing up of water would have stored groundwater for late season release, as well as captured sediment loads. Beginning in the 1830’s, trappers began removing beaver, and records indicate that by the 1850’s, beaver were nearly eliminated in the Scott River. The near elimination of beavers and consequently their dams, probably reduced channel complexity. These alterations would have impacted the riparian species as well. Although no specific documentation remains in the written record for such effects in the Scott River watershed, the ecological ramifications of beaver extirpation are well-documented for North America (see Naiman et al. 1988 for a review).

Historical channel alterations

The Scott River watershed has a history of more recent channel alterations; primarily for flood control, although gold mining played a role in the tributaries and along a six mile reach of the Scott River (Scott Tailings centered around River mile 54).

Hydraulic mining was at its peak in California by the 1880’s, and many tributaries to the Scott River experienced some hydraulic mining (e.g., Miners Creek, Shackleford-Mill

Creek). The nature of hydraulic mining caused a devastating effect on the riparian environment and agricultural systems throughout California. In 1943 a large Yuba dredge began operating in the Scott River below Callahan and in several tributaries, excavating down 50-60 feet to bedrock, processing and piling millions of cubic yards of gravel and soil, and re-routing the river along the edge of the flood plain. The dredge operated through the early 1950's. Below Callahan, the tailings are piled along 6 miles of the river, and are as tall as 40 feet in places. This reach of the river channels water rapidly and does not connect with any historic flood plain.

Tributaries impacted by dredge mining include the South Fork Scott River, Miners Creek, lower Sugar Creek, and McAdams Creek, (Scott River TMDL, Appendix A).

The first channel straightening and leveeing was completed by the Army Corps of Engineers on the Scott River mainstem in the 1930’s (Western Sentinel Aug 10th, 1938). The clearing and leveeing occurred between the mouth of Etna Creek and Kidder Creek, and the lower portions of Kidder Creek. This clearing and leveeing resulted in enormous bank destabilization, channel widening, and downstream deposition of wide and deep gravel bars. Some of the leveed banks were armored again following breaching caused by the 1955 flood (Dave Black, personal communication 2011). This bank armoring has led to channel down cutting throughout the leveed reach. Currently there is an entrenched and high energy channel from approximately Hwy 3 to Eller Lane (RM 36 to RM43). The banks along this portion of the Scott River are steep and tall, resulting in an estimated 10-12 feet from the top of bank to the summer water table. Additional channel alterations and bank armoring was done by riparian landowners and the Natural Resource Conservation Service in various tributaries following the flooding in 1955, 1965, and 1997.

The result of these historic channel alterations is that the Scott River from RM 36 to RM 43 and some tributary locations are deeply entrenched and cannot access the historic flood plain. This entrenchment and subsequent depth to water table creates river banks that are not capable of sustaining as robust riparian vegetation as they previously had, although most locations support some grasses.

Historical restoration efforts

Riparian restoration efforts in the Scott River Watershed began in the 1950’s. Following the 1955 flood, bank stabilization was completed throughout the watershed in order to stop active bank erosion (Scott TMDL-Appendix I). Restoration primarily included stream bank stabilization to prevent further stream bank erosion. The oldest riparian revegetation project implemented along the Scott River was installed by Alvin Levis at River Mile 38 in the early 1990’s. This vegetation has thrived and has reached mature growth. See Figure I. Aerial Overview of Alvin Lewis Planting site. In late afternoons during the summer it provides shade to the river channel (Alvin Lewis). Additionally, in 1997 approximately six miles of riparian restoration was completed from Fay Lane to French Creek. Some plantings in this reach have survived and are beginning to thrive. Some of the larger willows and cottonwoods are providing bank stabilization. (Appendix A contains documentation on these restoration efforts).

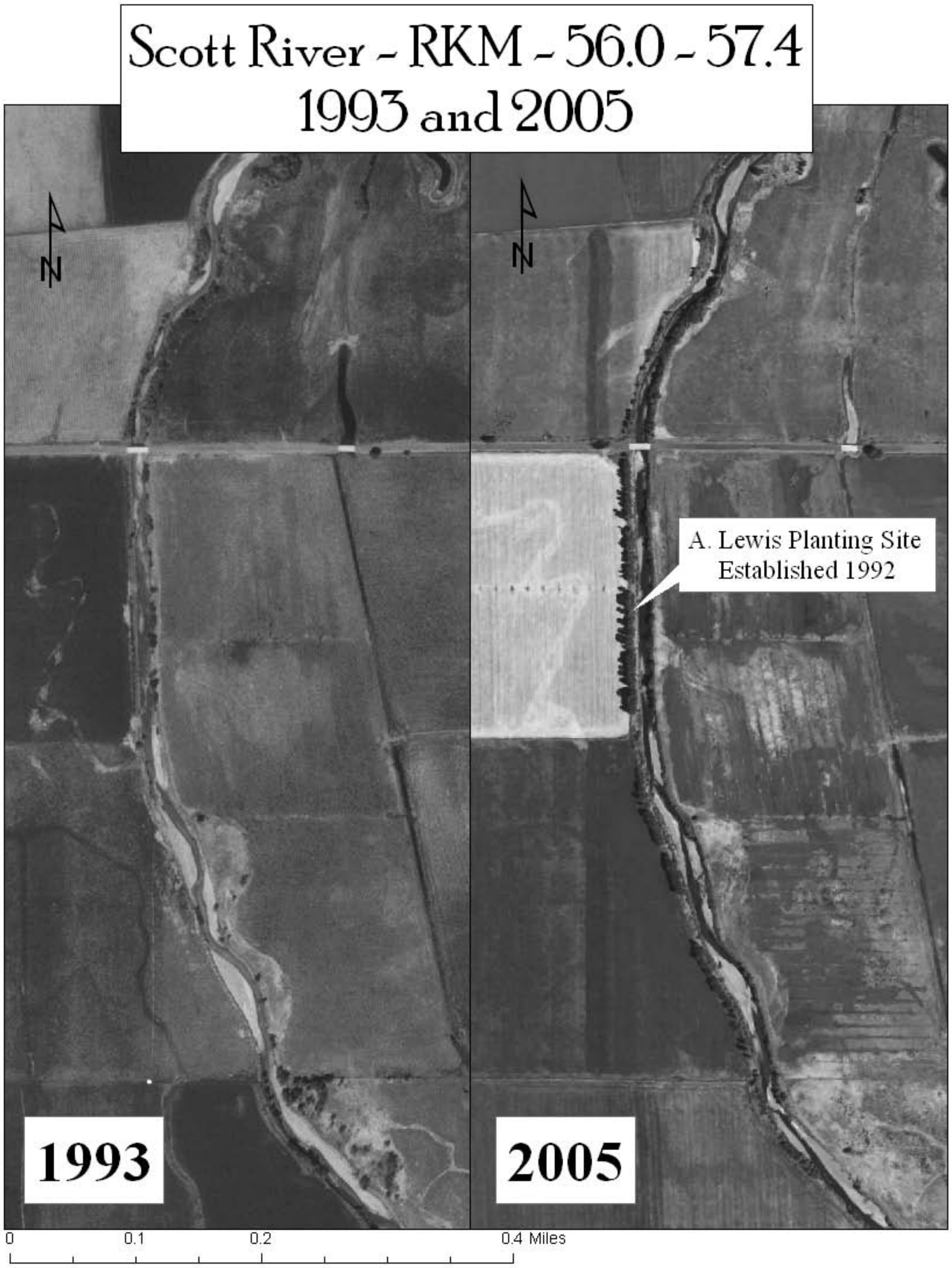


Figure 1 – Aerial photographs of planting site on the Scott River above and below Serpa Lane Bridge – 1993 and 2005. Tree growth on East Bank (left) is clear in the 2005 image.

IV. Current Riparian Restoration Efforts

Concern over fisheries habitat and water quality in the 1990's led to the implementation of riparian restoration efforts along the mainstem Scott River. In cooperation with NRCS or the RCD, or individually many landowners installed livestock exclusion fencing along the Scott River. To date more than 90% or more of lands adjacent to the Scott River which have grazing have been fenced, with additional fencing completed in 2013. Many riparian areas contain largely non-native vegetation; plants that compete and impede functional and native plants ability to derive nutrients and light from their environment. Managed Grazing can help to reestablish more functional vegetation in watersheds and to mitigate the effects of non-native vegetation (BLM 2006)

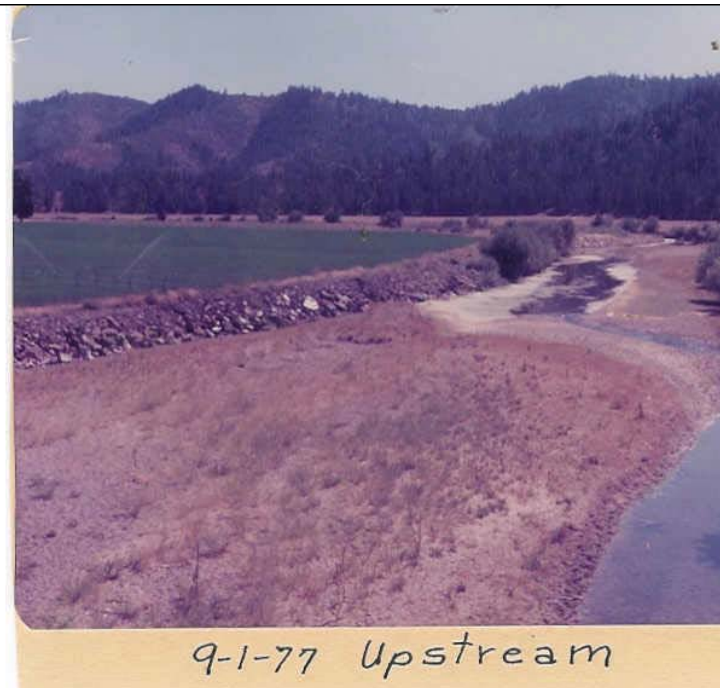
Between 1996 and 2007 the RCD implemented more than 350 acres of riparian planting along the Scott River and tributaries (Appendix A -Scott River Riparian Restoration Analysis 2007). These plantings showed mixed survival rates, but the highest survival was seen in the reach from Etna Creek to Fay Lane. Channel structure and proximity to water table played a role in this.

Efforts since 2007 have focused primarily on the tributaries, and the Scott River mainstem south of Etna Creek. These locations have shown more riparian replanting success, primarily due to channel size and structure, and the presence of a more stable water table. The most successful revegetation efforts have involved significant maintenance of the plantings, in the form of caging and seasonal irrigation (Silviera 2012, Lewis 1992).

Riparian Restoration is a long term committment

The series of photographs below show changes in riparian vegetation in the Scott River Watershed over a 30-50 year timeframe. These photos show an improvement in riparian vegetation. However, vegetative growth takes a long time in the extreme conditions that exist along the gravel bars and banks of the Scott River.

	February 1965 Looking downstream at the mouth of French Creek following the 1964 flood.
	**May 2008 Same location as above,** following extensive riparian planting and fencing beginning in the late 1990's.

	Sept 1, 1977 Scott River at Meamber Bridge looking upstream. Flows at the USGS gage (Rm 21.5) recorded at 6 cfs.
	July 28, 2004 Scott River same location as above, USGS Flows recorded at 39 cfs

Recovery takes Time

Timeline : Fay Lane Bridge

The following images were taken from the Fay Lane Bridge, looking North toward Fort Jones. Note the appearance of vegetation in the lower Right Hand corner.

Faye Lane Bridge, directly after 1964 Flood

Looking North, 1977

1989

July 2004

May 2013

V. Current Conditions

The following section describes the unique characteristics of various reaches of the Scott River and tributaries. This description includes how the reach characteristics (i.e., channel structure, depth to groundwater, bank substrate) impact restoration design and planning.

Geomorphic Reach Descriptions – Scott River Mainstem

For the purpose of this analysis, the Scott River was divided into five general reaches. Reach breaks were developed based on geomorphic survey data (channel cross-sections & longitudinal profiles), channel type data, documentation from long term DWR well data, and documentation from local revegetation efforts. Available data has shown that both the depth to low flow water table, and the available width of floodplain (i.e., riparian corridor) varies from reach to reach along the Scott River Mainstem (Siskiyou RCD 2009). For the purpose of riparian analysis and planning, the Scott River mainstem has been broken into the following four reaches based on channel characteristics. These reaches are;

Reach I. Scott River at Callahan to end of tailing piles (RM 57.1 - 52.1).

Reach II. Scott River End of tailings piles to Youngs Dam (RM 52.1 - 46.7).

Reach III. Scott River Youngs Dam to ~1.5 miles downstream of Etna Creek (RM 46.7 – 41.4).

Reach IV. Scott River ~1.5 miles downstream of Etna Creek to Oro Fino Creek (RM 41.4 - 29.3).

Reach V. Scott River at Oro Fino Creek (RM 29.3) to River Mile 21.

See Figure # 2 for a location of reach breaks.

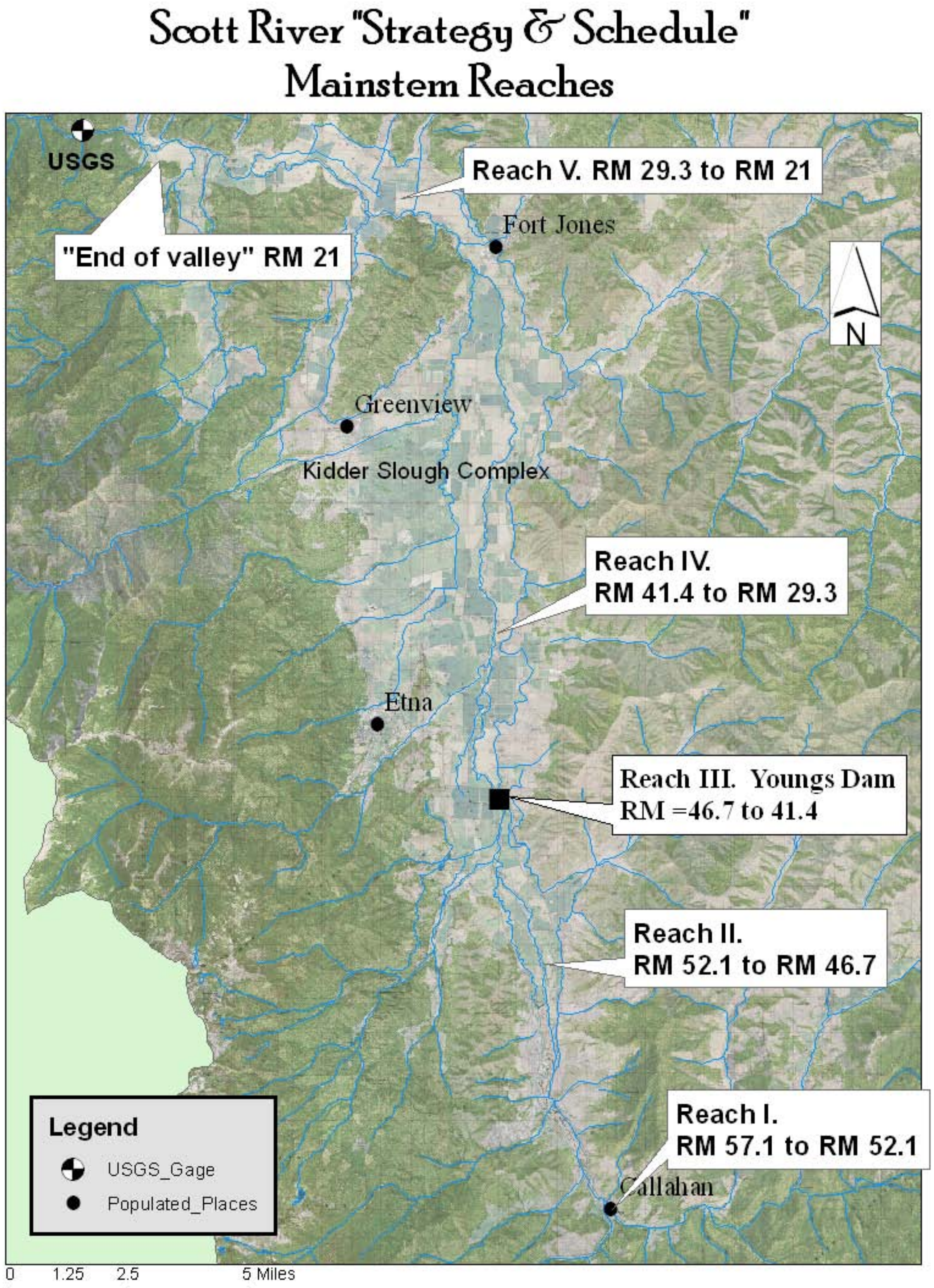


Figure - #2 – Main stem Scott River reach breaks.

Reach descriptions

Reach I. Scott River Callahan to end of tailing piles (RM 57.1 -52.1)

This reach begins at the confluence of the East and South Forks of the Scott River (RM 57.5), and is predominated by the six miles of tailing piles left by the Yuba Dredge in the 1930's. Some areas of this reach have near vertical banks of tailing piles directly adjacent to the active channel. Cross-section data collected in 2010 shows that the banks can be higher than the channel thalweg by more than 20 feet in parts of this reach. Most of the reach has limited amounts of riparian vegetation.

For the most part the river has no access to a flood plain due to the dredge piles, and little to no soil present on the dredge spoils. See **Figure 3 Aerial Imagery of Scott River Tailings.** The bottom of **Figure 3** clearly shows the dredge piles present throughout this reach.

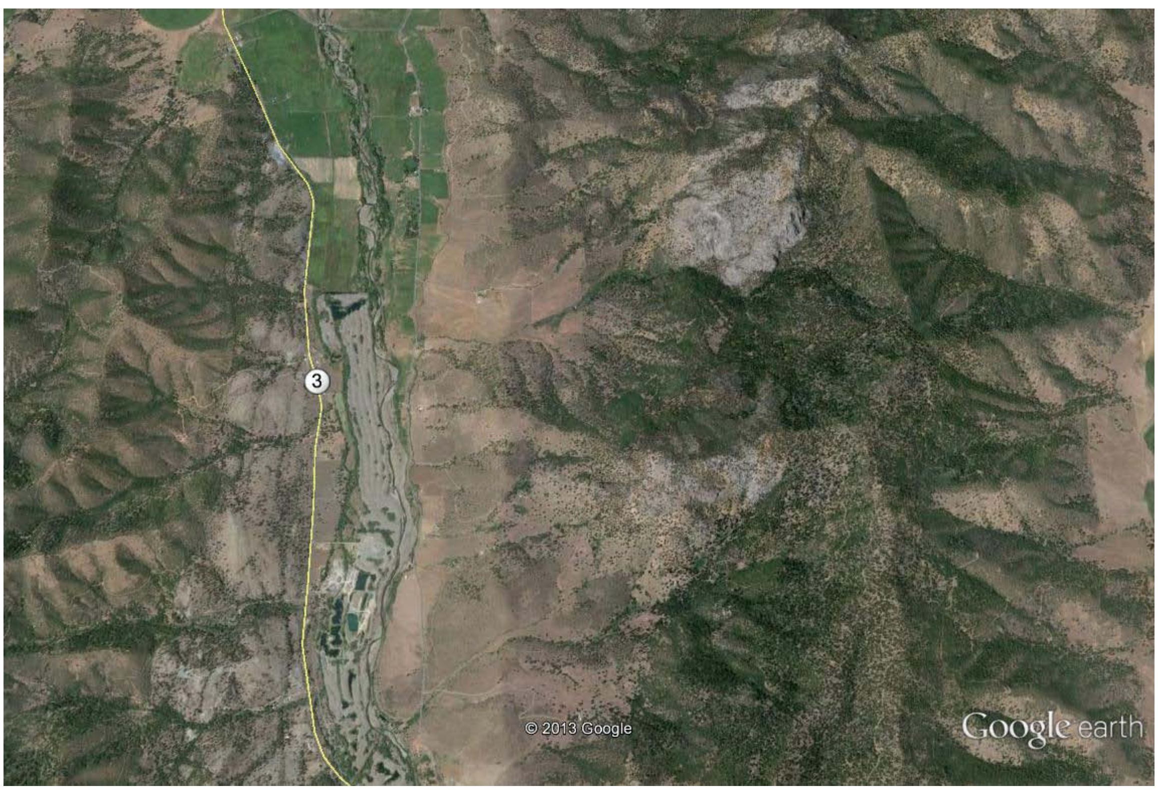


Figure 3. Image of Scott River Tailing, imagery Google Earth July 6, 2012.

RKM 86.1 - 85.5 - NAIP 2010

Figure 4. Section of the Callahan tailings

The 2,500 foot segment shown in Figure 4. located at the downstream end of the tailing reach, was restored to a wider channel and flood plain in 2007. This reach is located where the tailings piles begin to taper off and open up to a wider channel. This lower portion of this reach has some potential to establish a riparian corridor. **See Appendix C for cross-section information.** However, the substrate in this reach is extremely large cobble with little to no fines present. The reach is very hot and dry, and the river goes subsurface at RKM 85.5 (RM 53.12). The river resurfaces a few miles downstream, and is cooled from the time spent subsurface.

Reach II. Scott River End of tailings piles to Youngs Dam (RM 52.1-46.7)

This reach is defined by a wide floodplain and riparian zone with a relatively shallow water table, compared to the rest of the Scott River. The combined width of the available riparian zone on both sides of the stream varies from 200 to 1,000 feet, with an average of 600 feet (RCD data 2010). The available riparian zone is identified as the area between riparian exclusion fencing and the stream bank. This reach has the widest fenced riparian land and flood plain on the main stem Scott River. All locations in this reach with livestock have had exclusion fencing installed for 15 years or more. Figure 3 shows aerial imagery (GoogleEarth) taken in 2012. **Figure 5** shows the aerial imagry of this reach, with French Creek entering the Scott River in the upper left corner.

This reach has braids and side channels present south of the Fay Lane bridge, and access to historic side channels floodplains north of the Fay Lane Bridge.

Beaver are present in **Reach II** and **Reach III**. Current beaver dam building activity in lower French Creek and the Scott River in the vicinity of Wolford Slough may be raising groundwater elevations and contributing to the success of the plantings in this reach. Figure 6 below shows the successful plantings established in 1996 and 1997.

Figure 5 . Reach II. French Creek is seen entering the Scott River Center left of image.

Figure 6: Scott River vicinity of French Creek (Middle left of image) and Wolford Slough(bottom left quarter of image) Lidar 2010

Planting rows visible in Figure 6 were planted in 1997 as part of the Fay Lane Project. These planting are some of the most successful in the Scott River, both in terms of vigor and survival.

In addition to the wide riparian zone, this reach has considerable surface and sub-surface influence from west side perennial streams (e.g., French Creek, and Wolford Slough.) Surface and subsurface flows from these streams likely contributes to the relatively high water table in summer. Stream channel cross-sections taken on the Scott River at Wolford Slough (,RM 48.47) indicate that ground surface elevation of the terraces adjacent to the river are 4-7 feet above the thalweg of the Scott River, which should roughly correlate with base flow water table. **See Appendix D for cross-section information.** Figure 6 depicts Wolford slough on the left, just upstream from the mouth of French Creek. The flow is from the bottom to the top of the image. In the right hand corner it is possible to see an old channel. Based on previous plantings and cross-section information, it is anticipated that all the land between the old channel and Wolford Slough would show a high survival rate for riparian replanting.

Previous riparian replanting in this reach along the west side of the Scott River, upstream from French Creek have been some of the most successful in the watershed (Scott River Riparian Restoration Analysis 2009). This planting is visible in Figure 6 above. The relatively high water table and influence of French Creek and Wolford Slough contributed to the success of these plantings. Supplemental planting was completed in this area in spring of 2013 to expand the existing riparian corridor. While livestock exclusion fencing is installed on the entire stretch of Scott River in this reach, deer, elk and beaver can severely damage young plantings.

Reach III. Scott River Youngs Dam to ~ 1.5 miles downstream of Etna Creek (RM 46.7 –RM 41.4)

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 300 to 1,000 feet, with an average width of 350 feet. This reach has less available riparian and floodplain land on average compared to Reach II, but still maintains some meander and good riparian planting potential. Figure 7 shows aerial imagery of this reach. The existing meander bends are located upstream of the mouth of Etna Creek..

Many areas of stream bank that were actively eroding following the 1955 flood event have been stabilized with large rock rip rap. Several areas of successful riparian and non-riparian plantings were introduced by the Soil Conservation Service through this reach.

This reach is characterized by limited floodplain connectivity with the majority of the land adjacent to the active channel, and is comprised of leveed stream banks.

Figure 7. Reach III Google Earth Imagery July 2012.

Cross section data collected (2010) at Etna Creek (RM 40) shows that the low flow depth to water may be 5-7 feet in a normal water year.

Reach IV. Scott River ~ 1.5 miles downstream of Etna Creek to Oro Fino Creek (RM 41.4 – RM 29.3)

A large portion of this reach of the Scott River was “straightened, cleared and leveed” by the Army Corp of Engineers in the late 1930’s. According to Wayne Elmore of the NRCS Riparian Service Team (Elmore 2004) “*Portions of this reach of the river were channelized or leveed by the U.S. Army Corps of Engineers starting in 1938. The channelization straightened, and thus shortened the length of Scott River. The shorter length causes an increase in velocity and subsequently leads to channel bed down-cutting. The down-cutting causes an overall lowering of Scott River bed elevation. The river can no longer access its historic frequent floodplain, which prevents it from dissipating energies during frequent events like 2- and 5- year events. The increased river energy has resulted in the need to rip-rap many sections of the river to prevent loss of* *adjacent agricultural areas. The vegetation along the channel is relatively sparse for the size of the Scott River. Agricultural areas have encroached on the banks of the river and leave little space for riparian vegetation. The root masses of existing riparian plants are insufficient to withstand the erosive forces of peak flow events. It is probable that cottonwood and willow composed a substantial portion of a much wider historic riparian zone. Few of these stabilizing trees and shrubs are present. Historically, a wide area of live trees and roots were intertwined with down, buried and partially buried (Large woody material) LWM that combined to dissipate stream energy*."

Elmore further states that "*A consequence of the channelization and levees is that the broad and relatively level floodplain no longer stores water for late-season release. As soon as the spring flow drops, the deeply incised channel cutting through the valley floor allows the accumulated groundwater to run into the relatively empty Scott River. The channel now acts as a drainage ditch similar to those used to drain wet areas.* ***Historically, when the river bed was higher, the hydrostatic pressure of the river and its saturated bed held back the groundwater in the valley until late in the summer and early fall.*** *Additionally, portions of the Scott Valley were historically home to large beaver colonies that created a maze of small dam complexes that stored large quantities of water. This water was gradually released during the late summer as adjacent river flows decreased. A greater amount of water was in the river longer when all the tributaries were at full potential for water storage. The fact that more water was infiltrated throughout the landscape, tributary floodplains, and valley floodplain, created a regime within which a longer period of time was required for groundwater molecules to wait their turn to exit the Scott River watershed*."

Patterson, Johnson, and Crystal Creeks enter this reach of the river from the west, and have stretches that only flow subsurface, then resurface and combine to form the Big Slough. Big Slough joins Kidder Creek to the east of Greenview and Kidder Creek joins the Scott River upstream of the confluence with Moffett Creek. The affects on the groundwater elevation from the major tributaries to the west of the Scott River in this reach is largely unknown.

Oro Fino Creek enters this reach of the Scott River from the south, downstream of Fort Jones, and Moffet Creek enters the north. These tributaries are dry during the summer months at and above their confluence with the Scott River. There is very little to no riparian vegetation along the dry reaches of the tributaries.

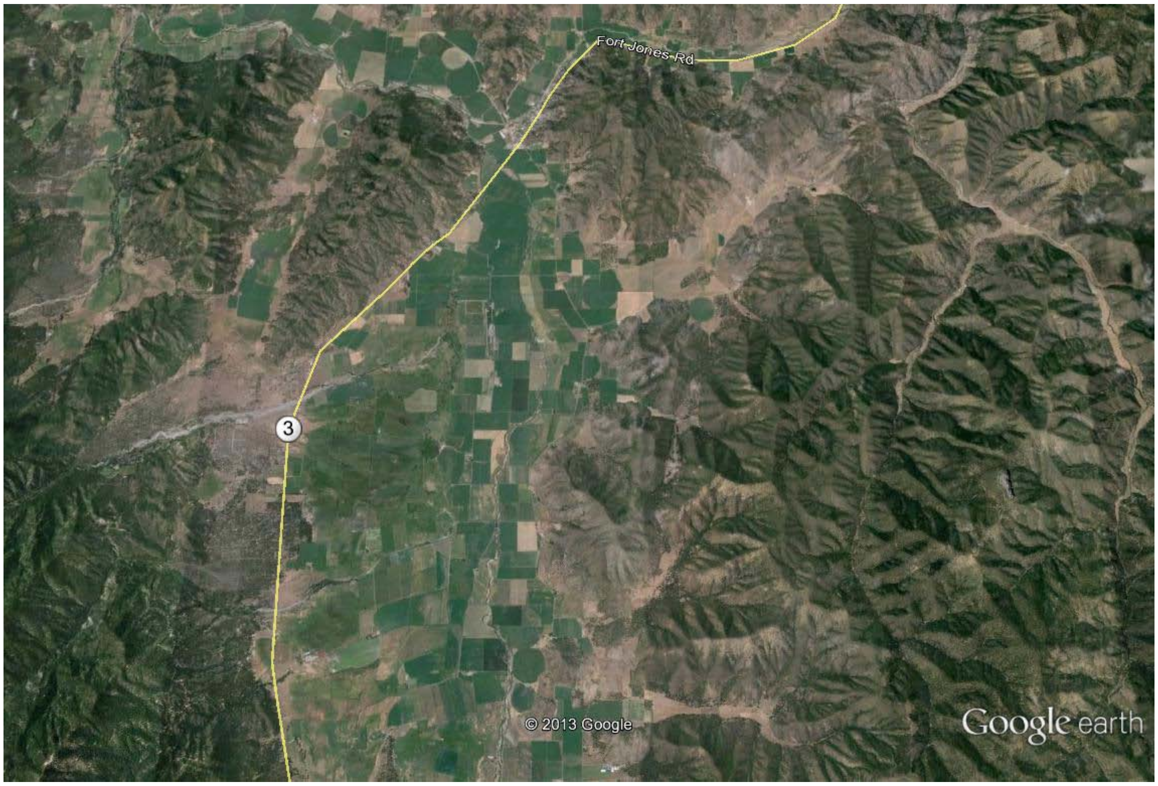


Figure 8. Reach IV. Aerial Imagery Google Earth 2012

A stretch of the Scott River in this reach, approximately 3 miles long , has an average of less than 110 ft of combined available land on both sides of the river. (See Figure 9 below). This section of the reach has the smallest average width of available land adjacent to the stream for riparian planting and potentially has the greatest distance from "riparian" landforms to the low flow surface and groundwater elevations. Based on observations recorded in planting contract final reports and observations in the field it is estimated that ground surface elevations on the adjacent terraces is between 8-11 feet above the low flow surface and groundwater elevations. The rest of the reach has an available width for riparian planting is uniform throughout the majority of the reach with only a few locations in which the combined available width is less than 300 feet.

An important feature of this reach is that it is at the point where the Scott River makes a sharp turn and flows due West. This alignment of the river channel from RM 31 to the mouth of the Scott River makes it nearly impossible for riparian vegetation to provide shade during the afternoons. However, riparian vegetation can still play a role in sediment management and groundwater recharge.

RKM 55.8 - 56.4 - NAIP 2010

Figure 9 – Representative section of the leveed section of Reach IV around RM 34.

Reach V. Scott River at Oro Fino Creek (RM 29.3) to River Mile 21.

This reach has some similar characteristics to Reach III, but is not dominated by high elevation levees. This reach of the Scott River is dominated by gravel and cobble throughout the stream banks and adjacent floodplains, with little soils for plantings to establish. Historic planting sites varied from sandy loam to high gravel bars. The distance to groundwater in the riparian corridor is estimated to be greater than 10 feet in many locations, but no rigorous data is currently available. To date, no current channel cross-section data is available for this reach. Indian and Rattlesnake Creek enter from the North and Shackleford-Mill and Oro-Fino Creeks enter from the South. Oro-Fino, Indian and Rattlesnake Creek flow sub-surface 6-9 months out of the year. Shackleford-Mill typically goes sub-surface in late July until the first significant fall rain, which generally occurs in October or November.

Previous plantings done between the mouth Kidder Creek and Oro Fino Creek were unsuccessful. It is hypothesized that the water table recedes too fast in the summer for plantings to establish roots. However, to date planting methods in the reach have not included pole cuttings trenched down to the low flow water table. This method will be implemented in the spring of 2014.

Figure10 .Aerial Imagery of Reach V. Google Earth July 2012

Geomorphic Reach Descriptions – Tributaries

I. East Fork Scott River

The East Fork has much of the same land use patterns seen in the mainstem Scott River. The full extent of the East Fork flows perennially, with no known dry reaches. Currently little is known about the condition of the riparian corridor in this reach, other than aerial images captured during the 2003 FLIR flyover of the Scott River (Watershed Sciences 2003). A stream habitat inventory completed in 2002 (CDWR 2002) on the mainstem Scott River found the reach to be moderately entrenched with stable banks. The report recommended planting willow, alder and Doug Fir along the streambanks. Water temperatures in the tributaries are slightly elevated, due to historic land management. The East Fork has not been topographically surveyed. Visual observations indicate that it is not down cut. It is expected that this location will respond well to planting, in conjunction with livestock exclusion fencing and grazing management

II. South Fork Scott River

The South Fork Scott River flows perennially, and maintains cold water temperatures; due to topographic shading and snow-melt. The South Fork Scott River was also impacted by hydraulic mining operations in the late 1800's. This mining left many mining piles and exposed bedrock, which limits the success of riparian vegetation. However, this reach is dominated by bedrock, and snow-melt water temperatures are cold (<16 C), so it is not a priority location for temperature or sediment control.

III. Alluvial reaches of Kidder, Patterson, and Etna Creek .

Historic land use practices led to a build-up of large alluvium in the lower gradient reaches of these tributaries, primarily above and below the Hwy 3 crossings. This is typically large cobble which does not hold soil or water, and is not suitable for riparian establishment. The stream channels are very wide in these reaches, making it difficult to effectively shade the channel. These alluvial reaches go subsurface annually, even in wet water years. Outside of the alluvial reaches, these tributaries maintain adequate riparian canopy and cold water temperatures. These alluvial reaches are candidate for geomorphic analysis and instream enhancement projects prior to installation of any riparian enhancement efforts.

Figure 11. Lower alluvial reach of Etna Creek.

Figure 12. Alluvial reach of Patterson Creek upstream and downstream of Highway 3.

Figure 13. Alluvial reach of Kidder Creek.

IV. Shackleford-Mill Creek

Shackleford Creek has two alluvial reaches, the first is in the lower ½ mile at the confluence with the Scott River, and the other reach is on Quartz Valley Indian Reservation, upstream from the Quartz Valley Rd Bridge. (See Figure 14.) Other than those dry reaches, Shackleford Creek maintains perennial flows, suitable water temperatures for salmonids, and complex rearing habitat. The existing riparian condition is adequate, and many locations have undergone natural recruitment following exclusion fencing. Site specific replanting would be effective in the lower sections of Shackleford Creek. It is not clear at this time if the alluvial reaches that currently go sub-surface can be returned to perennial flow. The substrate in these reaches is large rock and cobble dominated and not likely to support riparian replanting.

Riparian vegetation in lower Shackleford Creek.

Mill Creek maintains suitable canopy cover water temperatures for approximately 2 miles upstream from the confluence with Shackleford Creek. After a ¼ mile of alluvial reach, Mill Creek again flows perennially, with adequate canopy cover. See Figure 15. No riparian replanting is recommended for this location at this time. Continued protection of the riparian corridor is strongly recommended.

Figure 14 Lower Shackleford-Mill Creek

Figure 15 Mill Creek (tributary to Shackleford Creek).

V. French Creek

Significant watershed-wide restoration has been implemented in the French Creek Watershed. French Creek has been the site of a significant amount of successful riparian replanting, as well as local efforts to reduce sediment contributions, primarily through road management (French Creek Watershed Advisory Group). French Creek maintains year-round flows, which contributes to a relatively high water table. Overall the riparian corridor is functioning with excellent canopy cover, although isolated locations are in need of site-specific planting.

Beaver play an important role in the riparian ecosystem of French Creek and the mainstem Scott in the vicinity of French Creek. The dam building in this area likely contributes significantly to an elevated groundwater table. Plantings implemented in the Scott River in the vicinity of French Creek have been some of the most successful in the watershed.

Figure 16. Scott River at the confluence with French Creek.

VI. Sugar Creek

Sugar Creek has no alluvial deposition section, and flows year-round. Sugar Creek has an active beaver population in the lower ½ mile, contributing to water storage and salmon habitat. The riparian canopy in Sugar Creek is mature, and provides sufficient shade to the creek. The combination of canopy, aspect, and snow-melt keep the water in Sugar Creek at an average of 16-18°C in the summer. At this time riparian replanting is not needed in Sugar Creek. However, some landowners have identified a need to protect key trees from beaver damage. This protection will be done on an as needed basis, with some tree caging beginning in 2013.

Figure 17. Sugar Creek.

VI. Kidder Slough

The Kidder Creek Slough is the area where Johnson Creek, Crystal Creek, and Patterson Creek come together and enter Kidder Creek. The Slough runs parallel to the Scott River and has significant surface and groundwater contributions. At this time little information is available regarding water temperatures and status of the riparian corridor.

Kidder Slough Complex

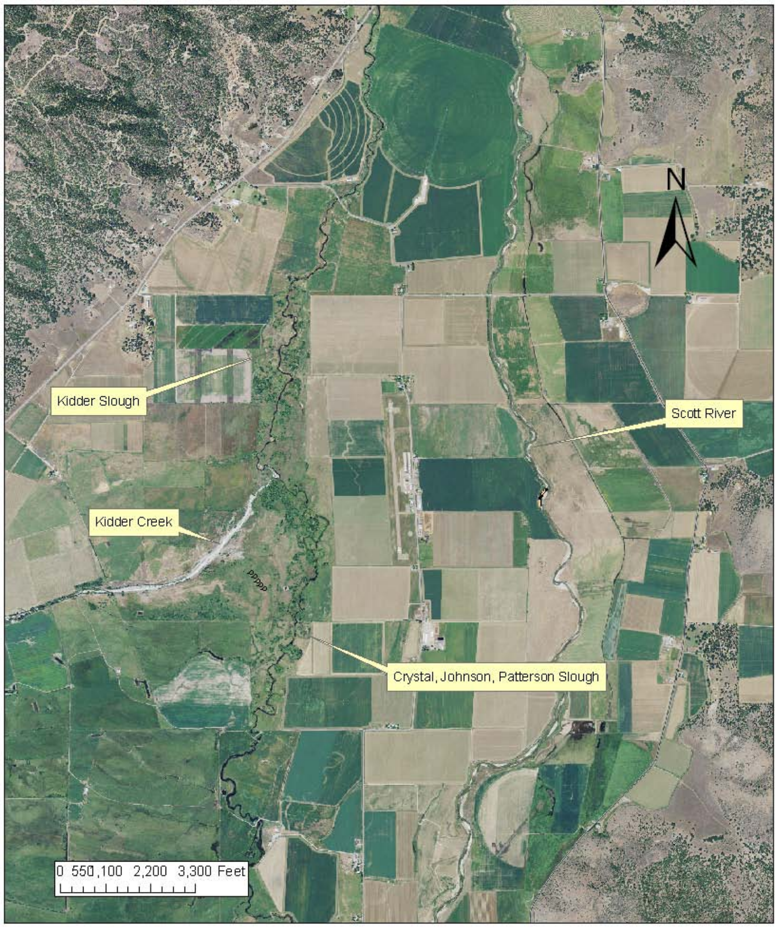


Figure 18. Kidder Slough (Crystal, Johnson, Patterson and Kidder Creek)

VI. General Restoration/Preservation Approaches

Successful work in similar watersheds

A literature search was done to evaluate which methods of riparian restoration have proven most successful in similar watersheds (i.e., similar annual air temperatures, rainfall, channel structure, etc.). Several papers have been written in the past five years which attempt to evaluate the success of riparian restoration efforts in the West. Overall, they all reach the following general conclusions.

- Active and passive riparian restoration efforts are both successful. (i.e., fencing versus replanting)
- Site assessment needs to be completed prior to the implementation of riparian restoration.
- All materials and methods should be selected on a site-specific basis.
- Maintenance needs to be part of the project design, both short term and long term.

A Master's Thesis completed at the University of Montana Missuola (Walls 2011) evaluated riparian revegetation projects completed in the Pacific Northwest. This evaluation specifically identified the following methods for locations with summer drought and course alluvium, such as many locations in the Scott River watershed.

- Planting rooted poles with most of the buds covered, which allows for root establishment without needing to support extensive above ground growth.
- Planting in excavated trenches down to water table.
- Use of a stinger (a hydraulic drill that injects water into the planting hole) in locations with large amounts of rock or rip-rap.
- These recommendations mirror observations made locally regarding successes and failures in riparian planting in the Scott River Watershed (see Appendix C).

Riparian Restoration Literature Search

The Natural Resource Conservation Service is very experienced in riparian restoration. They have published papers specific to riparian restoration in the arid climates (Hoag and Fripp 2005) such as the Scott River, and specific papers on various riparian species. In addition, in 2008, both Chris Hoag and Jon Fripp visited the Scott River Watershed and helped design a bioengineered stream bank project. This project was highly successful, and lessons learned have been incorporated into future planning efforts. Their information is incorporated into the recommendations at the end of the document and available in the bibliography.

Beaver management as a restoration tool

Throughout the United States, beaver are acknowledged as a low cost option for riparian restoration. Pollock (2003) states that "the limited available evidence suggests that key hydrologic functions of beaver dams are to: dissipate stream energy, attenuate peak flows, and increase groundwater recharge and retention, which increases summer low flows and elevates groundwater levels in stream valleys, thus expanding the extent of riparian vegetation".

The positive impacts of beaver activity that have been noted in the mainstem Scott River and tributaries, as well as the extensive national literature describing the benefits of this keystone species, has led the Scott River Watershed Council (SRWC) to identify the restoration of beaver throughout the watershed as a prime recovery strategy. The SRWC has been a participant in a multi-stake holder group seeking to lower regulatory barriers to the successful support of beaver in the watershed. In addition they have spear headed a volunteer effort to mitigate nuisance issues that occur with human beaver cohabitation such as culvert blockage and large tree damage. To date, two culvert maintenance devices ("beaver deceivers"), and a pond leveler have been installed, and a tree protection project has been accomplished, with others planned in the near future. The consideration of supporting beaver habitat, allowing natural, reintroduction of the species throughout the watershed is considered to be an important component of watershed restoration, which could provide considerable benefit in terms of raised water table, decreased sediment loads, improved fish habitat, and increased vegetation with all of its associated benefits, on a very cost effective basis.

Best Science

Scott River Mainstem

In 2004, at the request of the Scott River Watershed Council, the Natural Resource Conservation Service Riparian Service Team visited a series of sites on the Scott River and tributaries (Elmore 2004).

The NRCS Riparian Service Team made the following three key recommendations for enhancing the Scott River riparian corridor, following their field tour in 2004;

1.) Expand the riparian corridor.

2.) Determine the effects of the dredge tailings on the rivers function.

3.) Recovery of the channel bottom elevation.

Through 2007-2009 the Siskiyou RCD completed an analysis of all previous riparian planting in the Scott River, in order to determine which methods were most effective. The complete report is available in Appendix A. Key recommendations from that analysis are:

1.) Caging of trees is necessary to prevent animal browse (deer, elk, beaver, occasional stray bovine).

2.) Pole cuttings should be planted to the low flow water table depths. In locations with year-round water this may provide sufficient water.

Data Gaps

The following data gaps have been identified by the Riparian Planning committee as necessary data to fully develop an in stream restoration strategy for the Scott River:

- Geomorphic Survey and Analysis of the Scott River mainstem and Patterson Creek below Hwy 3, Moffett Creek. Analysis should include recommendations for restoring the aggraded alluvial reaches.

- East Fork Scott River

- Kidder Creek Slough Complex; this stretch should be investigated for riparian restoration need and potential, as well as quantification of contribution to the groundwater aquifer and late season flows.

- Local organizations (e.g., Siskiyou RCD and Scott River Watershed Council) should investigate the possibility of establishing “nurseries” of native cottonwood and pine to serve as sources for future planting efforts.

- Bring the National Riparian Service team back to the Scott River for another site visit.

- Develop a Beaver Management and Enhancement Plan.

  - Identity locations where land use and channel structure provide the potential for beaver to thrive without negatively impacting adjacent landowners

  - Host a workshop with Riparian experts (eg. NRCS Riparian Service Team) and beaver experts (Michael Pollock –NOAA, Mike Callahan)

VII. Recommended Methods

Restoration (e.g. selection of species, use of irrigation, cuttings vs. rooted trees, depth of planting relative to water table, streambank bioengineering, grade control structures, floodplain restoration, beaver enhancement, etc).

General restoration methods

The following restoration methods are general recommendations for any site to be treated.

Scott River Mainstem

- Utilize site evaluation form using the form in Appendix E. for prioritization & planning, and photo-documentation.
- For pole cuttings, dormant stock is the recommended planting material. If timing restraints don't allow for planting of dormant stock, overplant (2x) to allow for dieback.
- Protection and maintenance of existing natural vegetation and plantings. It was discovered that older plantings (>10 years) had suffered extensively from animal browse (beaver & elk). The animal browse is causing the cottonwoods to grow bushy rather than with one trunk A subset of these plantings need to be caged to prevent further damage, and encourage one main trunk. In the future, plantings should be visited annually, if possible, to observe for damage.
- Management of noxious weeds in riparian zones through methods such as; managed grazing, hand digging, selected spraying.
- At sites with high potential for future bank erosion, bioengineered bank stabilization techniques should be used to prevent further bank erosion and promote riparian establishment.
- The priority will be to use native vegetation (cottonwood, willow, alder) preferably found within the project site or at a minimum within the sub-drainage being treated. Some sites may be appropriate for planting non-native species such as golden willow, poplar, anderscogens, water birch, locust, etc.

- Pound large size (1-3” diameter) poles of cottonwood & willow in with hammer.
- Trenching down to anticipated low flow water table, use rooted pole cuttings or slips. It is important to plant cottonwood poles within a few hours of cutting, however soaking cottonwood poles overnight in a willow-enzyme compound may prove beneficial to establishment and should be done on a pilot basis.
    - When planting poles, ensure stem-to-soil contact.
    - Leave a depression around the stem to collect water.
    - After planting, cut back stem to about 12” tall.
- Follow-up with maintenance the following year, trim back most of growth.
- Plant cottonwoods in close proximity to willows, as the cottonwoods may benefit from the rooting hormones in the willows (if ponds are available, try to soak cuttings for several weeks).
- All cottonwood and rooted stock (pine, etc.) will be caged up to 4 feet high to prevent deer browse and beaver damage. In more barren locations, a subset of willows should be caged to help with initial survival rates.
- Other site specific maintenance, taking into account potential irrigation methods, and soil type (i.e., adding topsoil to planting holes, watering for up to three years, leaving a bowl in the planting hole to collect water.)
- If possible, utilize rooted stock plantings.
- Alder (are quick growing and suitable for barren sites. Alder seedlings should be purchase from a local nursery .
- Planting of species suitable to support beaver. Beaver will feed on willow, alder, cottonwood, and other deciduous vegetation. If trees are caged for protection, additional food supply should be established to support existing beaver populations. (This is important in Reach II and III, and the tributaries.)

Tributary Locations

The first priority for planting sites in the tributaries should focus on locations with a stable channel above the alluvial reaches, such as:

- French Creek from Miners Creek to Hwy 3.
- Mill Creek from disconnected reach to confluence with Shackleford.
- Shackleford Creek from confluence with Mill to disconnected Reach.

Identified Locations with Native vegetation

Based upon observations during the inventory of previous riparian restoration projects, as well as observations from planting projects, several locations have been identified as having sufficient existing native vegetation to serve as a source for live planting stock. See Figure 18, native vegetation locations.

Planting Stock Locations

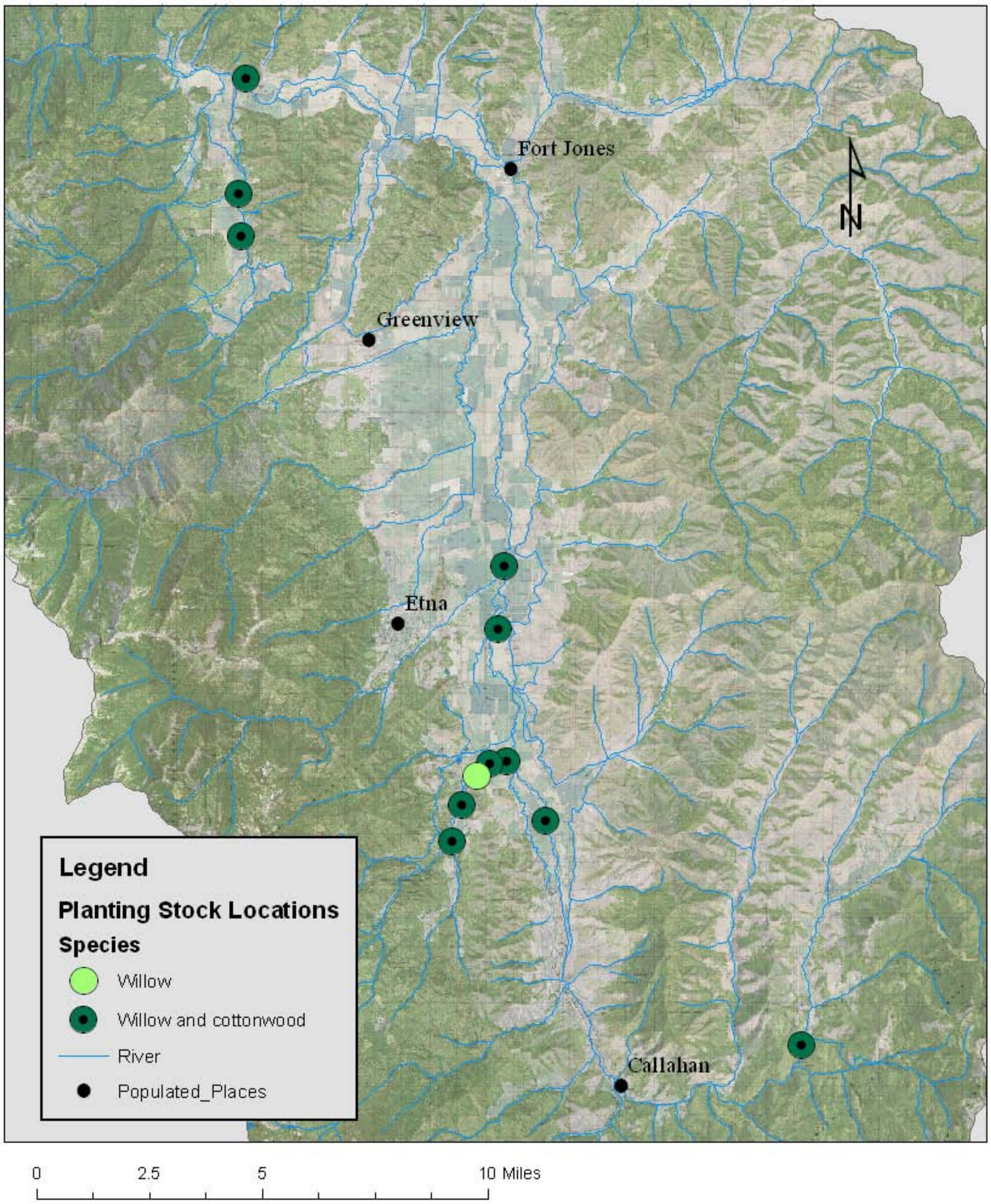


Figure 18: native vegetation locations

Reach Specific Restoration methods

Reach I: Callahan to downstream end of tailings piles

The historic geomorphic alterations to this reach have led to the banks being predominated by large cobble with little to no soil or fines present. A study needs to be done to determine the impact of the tailings on the function of the Scott River Floodplain downstream. This study should identify what treatments may be effective in improving stream function in this reach. As of 2013, a landowner group is working with the USFS and the Bureau of Reclamation to develop this study (See Appendix XX) The lower portion of this reach (RM 52.1 to ~50.7) has had treatment to remove some tailings and return the banks to a more natural alignment. This reach may have potential to benefit from riparian replanting, but is still lacking in soil and fines.

Reach II: Downstream end of tailing to SVID diversion structure

Reach II has been identified as the highest priority for riparian enhancement for the following reasons: a fully fenced riparian corridor, the width of the riparian corridor, the fact that water begins cool at top of reach as it emerges from the tailings, the estimated depth to water table, success of past plantings, existence of some riparian corridor, and proximity to existing habitat. The existing riparian corridor allows the river to follow a natural meander pattern, and is well suited to pole cuttings of broadleaf trees (i.e., alder, cottonwood, black locust, and willow). Reach II has the greatest potential for successful riparian restoration, based on known channel morphology, past revegetation success, documented distance to groundwater, the surface and subsurface contributions of Wolford Slough and French Creek, and the wide riparian corridor. In addition to the potential for success, this reach already has present many key habitat features for salmonids (cool water refugia, spawning gravels, deep pools, etc.). Increased riparian vegetation would enhance the instream features of the reach.

The following tasks have been identified by Siskiyou RCD staff for further enhancement of this reach:

1) Preservation of existing fencing and other setbacks which allows for the large fenced off riparian corridor. Much of the land was fenced in the mid-90’s through the USDA-NRCS Conservation Reserve Program. A priority for this reach will be to assist the landowners with maintaining the already dedicated setbacks and fencing in this reach.

2) Implementation of beaver management strategies. Beaver are present throughout this reach, including at the mouth of Wolford Slough and French Creek. Beaver activities can impact the operation of agricultural diversions, and threaten younger riparian plantings. However, the benefit of beaver for riparian enhancement, water storage and filtration, and providing salmon habitat is recognized. In order to further the coexistence of beaver and agriculture in this reach, the Scott River Watershed Council has identified two diversions in need of "beaver deceivers", and some riparian plantings in need of protective cages. These activities were implemented in 2012. See **Appendix C** for an extensive description of activities implemented to date.

3) Bioengineered bank stabilization at identified key sites. This reach has a well-established meander pattern, and a few locations with access to historic side channels. However, two actively eroding bank sites in the reach have been identified as needing bank stabilization to protect key fisheries habitat. The bank near the mouth of French Creek was treated in 2013 (See appendix C.) the other bank is being developed.

4) Maintenance of previously implemented plantings. Fencing of existing cottonwoods which were planted in the mid-90s, and are suffering from deer and elk browse. Re-establishment of cottonwoods is a priority along the mainstem Scott River, and in this reach. Planting of alternative species (willow, alder, black locust) will accompany this protection effort to provide a variety of species, and an alternate food source for the beaver.

5) Implementation of new planting in approximately 10 acres. Planting will be predominantly pole cuttings of willow, alder, cottonwood and black locust. Some higher elevation sites will be planted with pine or cedar.

Reach III. SVID Diversion Structure to 1.5 mile downstream of Etna Creek (RM 46.7 – 41.4)

This reach has been identified as the second highest priority reach. The upper 2+ miles of this reach has been put into a permanent conservation easement, and the remaining landowners have actively implemented restoration activities historically. The riparian corridor is wider in this location than the severely leveed section downstream in Reach IV.

The following tasks have been identified:

1.) Preservation of existing fencing and other setbacks that allow for the significant fenced off riparian corridor in the northern portion of this reach. A priority for this reach will be to assist the landowners with maintaining the already dedicated setbacks and fencing in this reach, and seeking funding to assist with fencing where it may still be needed.

2.) Bioengineered bank stabilization at identified key sites. This reach has a well established meander pattern, and only two sites in the reach have been identified as needing bank stabilization.

3.) Riparian replanting at locations identified as having potential to succeed.

Reach IV: Downstream of Etna Creek (RM 41.4) to Oro Fino (RM 29.3).

1) Bioengineered Stream Bank Enhancement – Scott River at RKM 58 (Reach III.)

This location is an actively eroding bank (800 feet) on the west side of the Scott River which is endangering the adjacent agricultural land. Bioengineered stream bank stabilization techniques will be utilized to protect the bank and establish riparian forest.

This site was selected because it is an active sediment source, and is endangering the agricultural land adjacent to the bank. Also, the location on the west bank will provide optimal shading of the river, irrigated plantings (1992) upstream from this site were successful, there is potential for irrigation, and the landowner is willing.

2) Bioengineered stream bank enhancement– Scott River at RKM 67.

This project addresses approximately 1000 feet of actively eroding stream bank, which is currently down cutting and reducing the river's ability to access the adjacent side channel. This site is on a bend in the river that will produce a significant amount of sediment, and erode agricultural land. The project site is on the west bank, which will provide for optimal stream shading.

There is a need to bring in a geomorphic expert to determine the potential for grade control structures to raise channel and increase groundwater elevations in the lower ½ of this reach. The current leveed state of this reach makes it unable to support a true riparian corridor.

Reach V. Scott River at Oro Fino Creek (RM 29.3) to River Mile 21.

This reach of the Scott River is the least studied of the mainstem Scott River. Due to the aspect (running east west), in order for any vegetation to shade the river, it will have to hang out over the river. Much of the river has existing willow vegetation (arroyo willow) which has grown into thickets. Bank beaver are also present in this reach. Suggested actions for this reach include:

1.) Selected hand thinning to thin the existing willows to allow other species to grow. This thinning will be accompanied by planting of cottonwood, alder and potentially pines/other conifer.

2.) Identification of locations that have potential to succeed for riparian planting.

VIII. Prioritization of Project Areas

Prioritization of specific project sites should follow the prioritization below

Potential to impact water quality

The following criteria are all important in developing a project:

1. Locations in Reach II. and Reach III. will be given higher priority than locations in other reaches.
2. Proximity to existing habitat and/or thermal refugia.
3. Depth to low flow water table.
4. Presence of existing vegetation, to build upon an existing riparian corridor.
5. Potential to reduce sediment contribution to the channel.
6. Past success (either at site or in adjacent location).
7. Potential to provide shade (i.e., affect water temperature).

At least two of these criteria must be present in order to continue to develop a project.

Landowner willingness

While landowner willingness is not a prioritization criteria for selection of potential project areas, it is a requirement for a project to be developed and implement.

See pre-project site evaluation form.

Pre-site Evaluation Form

Date ______________

Location description:

	Likelihood of success			Proximity to existing/restorable habitat				Potential to benefit water temperature	
Location	Depth to water table	available irrigation	in-channel	Existing Riparian	existing/potential side channel	Potential to reduce sediment'	Potential to postively impact groundwater	Exisitng cold water source	

IX. Project Scheduling

Time of year

A. Bioengineered Stream bank

   a. Permitting and wildlife considerations limit in-channel work to the low flow period of August- October, This is a challenging period to attempt riparian plantings. Greater success can be achieved through trenching to low-flow water table, and overplanting stock.

B. Off Channel.

   a. Off channel planting can be completed during the fall and winter/early spring dormant periods.

Sequence of projects

A. Schedule with identified projects

Riparian restoration schedule for Scott River- Draft October 2012

Task	**Location**	**Status**	**Timeframe**
Reach I. (Callahan to end of tailings)			
Completion of geomorphic analysis	**No recommendations until further geomorphic analysis is completed.**		
Seek funding for geomorphic analysis			as potential funding sources are identified.
Reach II. (End of tailings to SVID)			
Bioengeneered streambank	RM 48 across from French Creek	Funded	Fall 2013
Bioengeneered streambank	Merlot	In - development	Fall 2015
Maintence of previous planting (caging, etc)	Wolford Slough area (RM 48)	In progress	Fall 2012

Planting implementation	East Bank Scott Across from French Creek & south (~RM 48 miles)	In progress	Fall 2012
Planting implementation	West bank Scott at RM 48 , vicinity of Wolford Slough	In progress	Fall 2012
Maintenance	All plantings	annual	annually
Planting implemetation -10 acres	As locations are identified.	seek funding	annually
Reach III. SVID to 1.5 Miles downstream of Etna Creek			
Planting implementation	Scott at RM 40.4	Funded	Fall 2013
Maintenance	All plantings	annual	annually
Planting implemetation -10 acres	As locations are identified.	seek funding	annually
Reach IV. Etna Creek to Oro Fino Creek			
Bioengeneered streambank	Scott at RM 41	In - development	Fall 2015
Maintence of previous planting	Scott at RM 42	ongoing	ongoing by landowner
Bioengeneered streambank	Scott at RM 36	Funded	Fall 2013
Planting implementation	Scott at RM 39	Funded	Fall 2013
Planting implementation	Scott at RM 36	Funded	Fall 2013
Reach V. Oro Fino Creek to end of Valley			
Hand thinning of arroyo willow and selected planting of cottonwood and alder.	varied through reach, as landowners are identified.	in development	Fall 2013, Fall 2014
Identify potential planting locations			Annually
Planting implemetation -10 acres	As locations are identified.	seek funding	annually
Tibutaries			
Geomorpic survey and analysis of Patterson,Kidder, Etna Creek in alluvial sections.			when funding available

French Creek	As locations are identified.	seek funding	as identified & funding is available
Etna	As locations are identified.	seek funding	as identified & funding is available
Shackleford	As locations are identified.	seek funding	as identified & funding is available
Kidder	As locations are identified.	seek funding	as identified & funding is available
East Fork	As locations are identified.	seek funding	as identified & funding is available
Moffett	As locations are identified.	seek funding	as identified & funding is available

X. Permitting

The following permits will likely be needed for any ground-moving projects within the annual flood plain: California Dept. of Fish and Game 1600 permit, US Army Corps 404 permit, State Water Resources Control Board 401 Certification or Dredge and Fill Waste Discharge Requirements, and CEQA.

California Department of Fish and Game Lake and Streambed Alteration Agreement

http://www.dfg.ca.gov/habcon/1600/

California Department of Fish and Game – CEQA summary

http://www.dfg.ca.gov/habcon/ceqa/

State Water Resources Control Board 401 Water Quality Certification

http://www.waterboards.ca.gov/water_issues/programs/cwa401/

Manual hole digging, auger digging, and pounded pole cuttings can be done in the riparian corridor and adjacent flood plains without permits.

Access

Prior landowner access is an absolute requirement before any projects can be developed and implemented.

Resources for Landowners/Funding Sources

- State Water Resources Control Board

  - 319 H TMDL Implementation Annually, the California NPS Program allocates approximately $4.5 million of CWA Section 319(h) (CWA §319(h)) funding from the U.S. Environmental Protection Agency (U.S.EPA) to support implementation and planning projects that address water quality problems in surface and ground water resulting from NPS pollution. The goal of these projects is to ultimately lead to restoring the impacted beneficial uses in these water bodies. Projects are required to be located in a watershed that has an adopted/nearly adopted Total Maximum Daily Load (TMDL) for the constituent of concern and has been identified in the NPS Program Preferences. Projects focused on working toward achieving the goals of the TMDL to restore beneficial uses will be the most competitive in the selection process. http://www.swrcb.ca.gov/water_issues/programs/nps/solicitation_notice.shtml

- United States Fish and Wildlife Service-Partners for Fish and Wildlife

  - Contact Yreka Office 530-842-5763

- The California Riparian Habitat Conservation Program (CRHCP) ; Wildlife Conservation Board

  The program has a basic mission to develop coordinated conservation efforts aimed at protecting and restoring the state's riparian ecosystems. http://www.wcb.ca.gov/Riparian/

- Natural Resource Conservation Service (NRCS)

  NRCS offers voluntary programs to eligible landowners and agricultural producers to provide financial and technical assistance to help manage natural resources in a sustainable manner. Through these programs the agency approves contracts to provide financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on

agricultural lands and non-industrial private forest land.
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial

NRCS Programs

- The **Agricultural Management Assistance** (AMA) provides financial and technical assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations.

- The **Agricultural Water Enhancement Program** (AWEP) is a voluntary conservation initiative that provides financial and technical assistance to agricultural producers to implement agricultural water enhancement activities on agricultural land to conserve surface and ground water and improve water quality.

- **Conservation Innovation Grants (CIG)** is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production.

- The **Environmental Quality Incentives Program** (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length.

- The **Wildlife Habitat Incentive Program** (WHIP) is a voluntary program for conservation-minded landowners who want to develop and improve wildlife habitat on agricultural land, nonindustrial private forest land, and Indian land.

Monitoring

Photopoint monitoring

Photopoints will be established prior to implementation of any restoration activities to track success of the project. Ideally, photopoint locations will be GPS'd and documented on a USGS topo map or aerial photograph.

Ideally, photopoint monitoring will occur annually in the summer when vegetation is fully leafed out. The photopoint monitoring log below should be utilized for all photopoints.

SOP 4.2.1.4

PHOTO LOG FORM

Project:

Location:

Date:

Photographer

Team Members

Camera ID:

Photo #	Time	Photo Point ID	Photo pt Description & Location	Bearing to subjest	Subject Description

General Notes or Comments (weather, cloud cover, time of sunrise and sunset, other pertinent information)

Quantitative monitoring

Plant survival will be tracked to account for overall survival by site, as well as by species and planting methodology.

Adaptive management

Adaptive management is a structured, repetitive process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

In this way, decision making simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool which should be used not only to change a system, but also to learn about the system (Holling 1978). Because adaptive management is based on a learning process, it improves long - run management outcomes.

There are a number of scientific and social processes which are vital components of adaptive management, including:

1. Management is linked to appropriate temporal and spatial scales
2. Management retains a focus on statistical power and controls
3. Use of computer models to build synthesis and an embodied ecological consensus
4. Use of embodied ecological consensus to evaluate strategic alternatives
5. Communication of alternatives to political arena for negotiation of a selection

The achievement of these objectives requires an open management process which seeks to include past, present and future stakeholders. Adaptive management needs to at least maintain political openness, but usually aims to create it. Adaptive management must therefore be a scientific and social process. It must focus on the development of new institutions and institutional strategies in balance with scientific hypothesis and experimental frameworks (resilliance.org).

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Appendices

Scott River Riparian Restoration Analysis

Prepared by the Siskiyou RCD

For the United States Fish and Wildlife Service

Sept 2009

Table of Contents

Special Thanks to:

Scott Valley Landowners

Preston Harris- Siskiyou RCD

Introduction

Landowners and land managers in the Scott River Watershed have been proactively working to protect, restore and enhance the aquatic and riparian ecosystems for the past several decades. Concerns over the status of the Klamath River's anadromous fisheries have been a major impetus to restoration efforts instream and in the riparian corridor. The Scott River provides spawning and rearing habitat for a significant population of coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). The majority of anadromous habitat in the Scott River is within privately owned lands in the Scott Valley. The entire mainstem of the Scott River is privately owned for 38 miles (RM 57.1 to RM 19.1), as well as most of the lower reaches of the tributaries used by anadromous salmonids. Many of the landholders are small parcels which lack the financial resources to implement large scale restoration projects. This ownership pattern makes coordination and planning of effective restoration efforts complex and time consuming.

It is the goal of this analysis to evaluate the effectiveness of existing riparian protection and enhancement projects throughout the Scott Valley. This evaluation of previous effort is used to generate a series of recommended restoration and protection techniques that have worked in different areas of the watershed. Additionally, an evaluation of data pertaining to the current riparian condition, the distribution of target species and the potential for successful riparian recruitment has been performed to help prioritize future riparian restoration efforts.

The riparian ecosystem is a unique and complex assemblage of flora and fauna that is dependent on water. The riparian zone is the interface between the lotic ecosystem of the stream and the adjacent lands. The riparian zone has multiple functions that generate aquatic health and complexity while buffering potential pollution from adjacent lands. Roles of the riparian zone include: stabilize stream banks and adjacent soils with root structure, slow flood waters and filter sediment with the vegetation's "roughness", capture and filter polluted surface runoff, provide shade and reduce thermal inputs to the stream's surface water, provide nutrients (feed) to aquatic organisms, serve as a source of fish cover and future instream woody debris in the stream, and provide essential wildlife habitat. A properly functioning riparian zone provides many benefits that are essential to a healthy productive aquatic ecosystem. Additionally, an established and protected riparian zone can maintain itself and downstream reaches through natural recruitment through the dispersal of seed and other methods of propagation.

The development of the Scott River Watershed through a historic progression of resource utilization is characteristic of most watersheds in the Western United States. The itinerant fur trappers of the Hudson Bay Company were the first non indigenous people to discover the Scott Valley in the 1830's. These mountain men named the area "Beaver Valley" due to the extremely rich population of the desirable fur bearing mammal. Subsequent discovery of gold in the watershed by John W. Scott at Scott's Bar in 1850 triggered the renaming of the river and valley and heralded a century long period in which the methods of gold extraction significantly altered the stream's channel, floodplain and adjacent lands. Agricultural operations quickly followed the significant population of miners that were driven to the gold fields and the 20th century saw the Scott Valley largely populated by small family farms producing live stock, wheat and hay. The 20th century was additionally characterized by road building and timber harvest in the upslope areas of the Scott River Watershed and efforts to clear and straighten parts of the Scott River's channel in the Valley to reduce the regular occurrence of winter flooding. Severe bank erosion and channel alteration occurred in the Scott River during a series of floods and high flows in the late 1950's that triggered a campaign to stabilize banks and the river's course through bank stabilization utilizing large rock (rip-rap) armoring. This progression of development throughout the watershed has created a stream channel, riparian corridor and aquifer that are hypothesized to be significantly altered from the historic "natural" condition. Development of a restoration plan that identifies and works with current watershed conditions to improve overall stream and riparian function is essential to any chance for success in the developed streams of the American West.

Protection of the riparian corridor through cattle exclusion fencing followed by riparian planting efforts are believed to be two of the most important steps in restoring the quality of the adjacent stream. These activities were identified in the Scott River in the late 20th century as necessary to reduce sediment and thermal inputs to the stream channel while allowing for survival and natural recruitment of the riparian corridor. In order to address these needs, fencing and riparian planting have been a focus of the local landowners, Siskiyou RCD (RCD), Scott River Watershed Council (SRWC), Natural Resource Conservation Service (NRCS) and various funding sources.

Since the mid 1990's, approximately 275 acres of Scott River main stem and tributary have been planted. In addition, an estimated 90-100 miles of river and tributary have been fenced for livestock exclusion. Many of the stream reaches with documented coho salmon presence are currently protected with livestock exclusion fencing. Several significant reaches with no known riparian fencing have been identified outside of the areas with documented coho salmon. Protection of these areas for the improvement of ecosystem health and water quality is important. It is estimated that there is currently approximately 50 miles of stream in the Scott River that potentially needs livestock exclusion fence to protect the riparian corridor and stream banks.

Despite the time and energy that has been put into riparian restoration efforts in the Scott River, much of the Scott River corridor still has little to no shade providing vegetation (*i.e.*, mature trees). The planting efforts completed to date have had mixed success, from complete failure to sites with moderately good survival and growth.

The Scott River is listed under the California 303d list as impaired for temperature and sediment. The health of the riparian corridor plays a key role in water temperature, and impacts instream sediment levels. The Scott River Temperature and Sediment Total Maximum Daily Load (TMDL) Action Plan was adopted by the North Coast Regional Water Quality Control Board in 2006. The TMDL identifies specific shade requirements for the main stem Scott River and major tributaries.

Purpose

In order to better plan future riparian planting projects, develop the most cost effective riparian restoration projects and address TMDL requirements, the RCD has attempted to analyze all previous riparian planting efforts. This analysis includes an inventory of past projects to determine survival and current condition, an analysis of previous planting techniques, an analysis of the geomorphology of reaches of the Scott River and determination of locations most likely to respond to future planting efforts.

This project attempts to address the following specific tasks:

- Task 1 - Compile the documentation on past riparian projects.
- Task 2 - Map existing riparian protection and restoration projects.
- Task 3 - Complete inventories of the current condition of past restoration projects.
- Task 4 - Identify locations with intact riparian vegetation for use as planting stock.
- Task 5 - Identify and prioritize areas most likely to respond to restoration and protection efforts.
- Task 6 - Verify prioritization with the North Coast Regional Water Quality Control Board's riparian shade model, available fish spawning and rearing distributions and other applicable data sets.
- Task 7. Use expert judgment to develop effective restoration and protection prescriptions (techniques) for various landscapes of the Scott Valley.

Chapter 1 - Historical Impacts on the Riparian Corridor of the Scott River

Since fur trappers discovered the Scott Valley in the 1830's, a combination of human activities and acts of nature have altered the riparian corridor and surrounding landscape. When the earliest settlers arrived in the 1850's following the discovery of gold, the Scott River Valley was formerly referred to as Beaver Valley due to the large population of beaver in the valley floor. Beaver trapping was likely the earliest human activity to begin to significantly alter the "natural" conditions of the river.

Direct human impacts to the stream's channel and riparian corridor include extensive gold placer mining, channel clearing, straightening and leveeing, expansion of agricultural efforts, removal of large woody debris from riparian corridors and river channels and the beginning stages of riparian restoration efforts. The cumulative effect of human impacts interacting with natural events has played a large role in shaping the current stream and riparian condition. Natural processes that have altered the riparian and stream condition include disease and flood. Restoration effort success was limited by plant mortality due to the droughts of 1987-1992 and again 2001-2002. The accumulation of environmental and anthropogenic factors that have affected the current condition of the Scott River and its riparian corridor is well summarized in Kennedy, et al., 2005.

Gold mining was one of the earliest human activities to severely impact the Scott River and tributaries. Hydraulic mining was conducted in many tributaries to the Scott River for several decades. Hydraulic mining uses water under high pressure to mine alluvial deposits causing large amounts of sediment to be delivered into the river channel, changing the channel elevation and altering flood regimes. A group of farmers in the Sacramento Valley filed suit against the hydraulic miners in 1884 (Edwards Woodruff v. North Bloomfield Mining and Gravel Company). A federal judge ruled against the miners, however, in 1893 the United States Congress passed the Camminetti Act, which allowed hydraulic mining to continue if proper sediment control measures were in place. Hydraulic mining continued in California in various forms until the late 1960's. Abandoned hydraulic ditches still remain in many tributaries to the Scott River.

Several large tributaries of the Scott River (including McAdams Creek and the South Fork of the Scott River) have significant amounts of tailings along the stream's banks and floodplain. Large scale dredger mining of the Scott River's main stem (RM 52.3 – 56.4) from 1936 – 1951 by the Yuba Consolidated Gold Fields Company heavily impacted the channel and riparian corridor. Dredger mining essentially turns the river bed's substrate "upside down" compared to natural conditions. This leaves the surface substrate as primarily large cobble with little fines to provide nutrients and store water. Generally, the tailing piles are several feet in elevation above the water's surface limiting access to the floodplain and the dissipation of energies during high water events. Frank J. Jackson - a former Conservationist of the Siskiyou Soil Conservation District - stated in an undated document: "The handling of these dredger tailings and the damage they are causing to the best lands in Scott Valley was one of the most important reasons or motivations for the formation of the Siskiyou Soil Conservation District in 1949." (F.J. Jackson, Undated).

Figure 1. Aerial view of Scott River Tailing reach – confluence of Scott River Forks in extreme foreground

In the late 1930's, the Army Corp of Engineers cleared, straightened and leveed several miles of the main stem Scott River from approximately RM 33 to RM 43 in response to concern over flooding. The history of stream alterations to the Scott River Watershed is well summarized in Kennedy et al., 2005.

In addition to stream channel alteration, the riparian corridor of the Scott River was negatively impacted in multiple ways throughout the 1950's. In the early 1950's, infestations of the oystershell scale (*Lepidosaphes ulmi*) insect severely impacted willow growth and survival (Lewis 1992). The December 1955 flood caused significant bank erosion on the main stem Scott River. This was then followed by two drought years, (1959-1961) and then the 1964 flood which removed much of the existing riparian corridor along the main stem Scott River and tributaries. The historic photo below shows representative riparian and stream channel condition directly following the 1964 flood.

Figure 2. Scott River at Youngs Point (upper right) after the 1964 flood. (photo by F.J. Jackson)

Chapter 2 - Regulatory setting

Scott River TMDL and Scott River Watershed Wide Permitting Program (ITP)

Scott River TMDL Requirements

The Scott River watershed was listed as impaired for temperature and sediment in 2003 under the Clean Water Act 303(d) listing. The Scott River TMDL Action Plan was developed by the North Coast Regional Water Quality Control Board and adopted in September 2006. The Scott River TMDL calls for the Scott River to achieve a minimum amount of “effective shade” for stream temperature regulation. The potential effective shade was calculated by a model - Heatsource v.7 – for the main stem Scott River. The potential effective shade requirement varies throughout the watershed, dependent primarily upon elevation, aspect and bankfull channel width. The outputs of the model are summarized in **Appendix A**.

Scott River Watershed Wide Permitting Program (Incidental Take Permit)

In February 2004, the California Fish and Game Commission adopted the Coho Recovery Strategy. The Recovery Strategy emphasizes cooperation and collaboration, and recognizes the need for funding, public and private support for restoration actions, and maintaining a balance between regulatory and voluntary efforts to meet the goals of the Recovery Strategy. The Shasta and Scott River watersheds were identified for a pilot program to address coho salmon recovery issues and solutions related to agriculture and agricultural water use in Siskiyou County. The Recovery Strategy for California Coho Salmon (Feb 2004) identifies specific recommendations for the Scott and Shasta Rivers in the Shasta-Scott Pilot Program (Pilot Program). In addition to identifying recommendations for the Pilot Program, the Shasta-Scott Recovery Team identified the need to develop a programmatic implementation framework (i.e., an incidental take permit program “ITP”) that works toward the recovery of coho salmon, while affording take authorization to agricultural operators. The avoidance, minimization, and mitigation actions required by this Permit are consistent with the recovery tasks identified in the Shasta-Scott Pilot Program of the Recovery Strategy.

Scott River Watershed Wide Permit Program Requirements

The Scott River Watershed-wide Permit Program identifies specific mitigation obligations of the Siskiyou Resource Conservation District (SQRCD).

Under the terms of the Permit “the SQRCD shall prepare a plan that identifies in order of priority riparian locations in the Program Area that if fenced to exclude livestock would benefit coho salmon. The SQRCD shall submit this Priority Plan within one year of the effective date of the Permit. This Priority Plan will identify locations, and list those locations in order of priority. “

During the terms of the ITP the SQRCD is obligated to protect an average of two miles of additional stream every year with riparian exclusion fencing.

According to the terms of the Permit, sub-permitees may not graze livestock within a fenced riparian area unless the grazing is done in accordance with a grazing management plan prepared by the sub-permitee and approved by the Department. The grazing management plan shall address the timing, duration, and intensity of livestock grazing within the riparian zone and shall explain how the proposed management plan will result in improved riparian function and enhanced aquatic habitat.

Chapter 3 - Previous riparian analysis

An inventory of the riparian condition along both banks of twenty nine miles of the main stem Scott River (RM 52.0 to RM 22.2) was completed in 1991 (Lewis, 1992) The riparian survey identified stream banks with existing rip rap stabilization, stream banks with proposed rip rap stabilization, vegetation types in the riparian corridor and existing cattle exclusion fences. The survey, additionally, classified stream banks and riparian corridor condition along the river as being pristine, good, degrading or recovering. The inventory data is summarized in a series of maps and tables in the Lewis report.

At the time of this inventory, a questionnaire survey was completed by the landowners indicating their level of willingness to participate in future restoration efforts. The results of the survey indicated a high degree of willingness to address riparian condition through restoration. The riparian inventory completed by Alvin Lewis in 1991 determined that 55% of the sites inventoried were in good condition, and 45% were disturbed or degrading. In 1991, 64% of the sites that were determined to be in good condition had livestock exclusion fencing. Disturbed and degrading sites had livestock exclusion on less than 25% of the sites.

Lewis estimated that the average age of the riparian trees on the main stem Scott River was 19-20 years. This indicates that a large amount of the existing riparian vegetation was recruited after the 1964 flood, which removed a significant amount of vegetation on the main stem and tributaries.

Previous riparian restoration efforts:

A series of small and large riparian planting efforts have been performed in the tributaries and the main stem of the Scott River over the past two decades.

A small scale demonstration effort was completed by A. Lewis in conjunction with the riparian analysis to plant the riparian corridor in a section of the main stem Scott River above the Serpa Lane Bridge (RM 35-35.2). The plantings were subsequently irrigated by the landowner and Alvin Lewis for several years to insure initial survival and establishment. The cottonwood and golden willows (*Salix alba "Vitellina"*) planted and irrigated at this location are some of the largest and most successful products of riparian restoration in the main stem Scott River.

The Siskiyou RCD and CalForest Nursery performed extensive riparian restoration efforts in the Scott River from the end of the tailing pile to the mouth of French Creek (RM 48.1 to RM 51.0) in 1998 – 1999 using funds from the Cantara Trustees. Multiple plots of land were planted with a variety of tree species (*e.g.*, cottonwood, willow, pines) and planting techniques. A large amount of rooted stock was planted in rows and irrigated using drip line. A smaller amount of live cuttings were planted in holes excavated to the low flow water table. The plantings and irrigation were maintained and assessed for several years subsequent to planting. The Siskiyou RCD revisited the planting in 2008 and assessed the condition and density of riparian vegetation in the sites planted a decade earlier. Various levels of success of the Cantara plantings were documented in 2008.

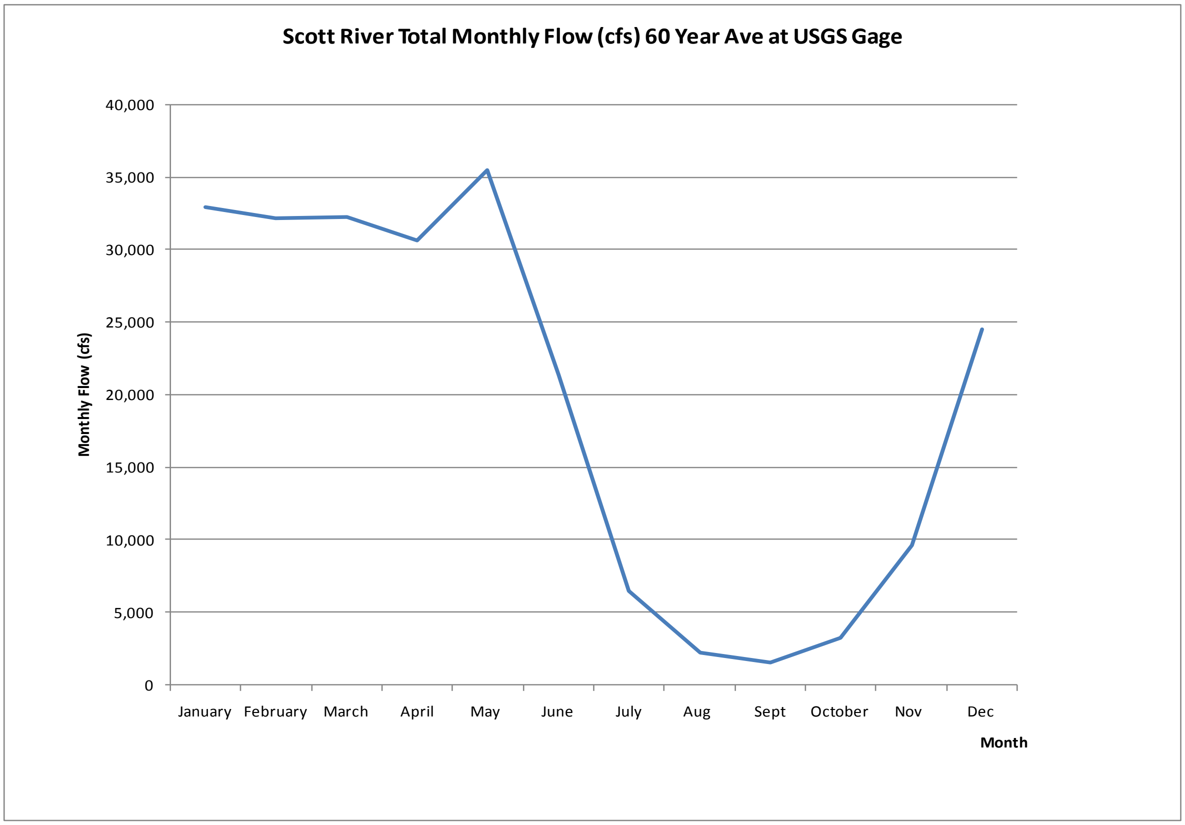
The Siskiyou RCD has performed multiple small scale riparian restoration projects throughout the Scott River and most major tributaries. Projects have been performed on the East Fork Scott River, French Creek, Kidder Creek, Moffettt Creek and Mill Creek in Quartz Valley. A variety of planting techniques were used on the different sites. The Siskiyou RCD revisited a majority of the planting sites in 2008 and inventoried the current condition.

Challenges to Riparian Restoration

The following are some of the most significant challenges that have limited the success of past riparian restoration efforts along the Scott River main stem.

Conditions on gravel bars: Many of the potential planting sites in the existing riparian corridor are predominantly composed of large cobbles which do not hold water well as the water table recedes in the spring. This condition makes it especially difficult for natural recruitment of cottonwood, which has a significant moisture requirement to establish new seedlings. In addition, the exposed cobble reflects significant amounts of heat (solar radiation) onto young seedlings causing potential cambium burn and death. It is estimated that temperatures on the gravel bars can exceed 110° F in the hottest part of summer. Attempts in the past to reduce the amount of solar reflection at some restoration sites included mulching of the soil adjacent to introduced plantings. The mulch was found to attract rodents which fed on and killed the seedlings (see below). The use of "shade cards" to shade new seedlings instead of mulching is a potential solution to preventing excessive solar radiation without increasing the amount of rodent browse.

Altered hydrologic regime and access to the flood plain: The Scott River typically has relatively high flows during the period of snow melt runoff which lasts from spring until early July. After this point instream flows, and potentially the water table, drop relatively rapidly (Figure 3). The rapidly dropping water table can cause the root structure of newly established plantings to become dry and die during the months of summer and early fall. The soil moisture in the soil profile above the water table (vadose zone) becomes extremely low to non-existent in areas that are not irrigated during the dry months of summer and fall. It is hypothesized that access to the aquifer's water table or irrigation is essential for the survival and establishment of riparian plantings.



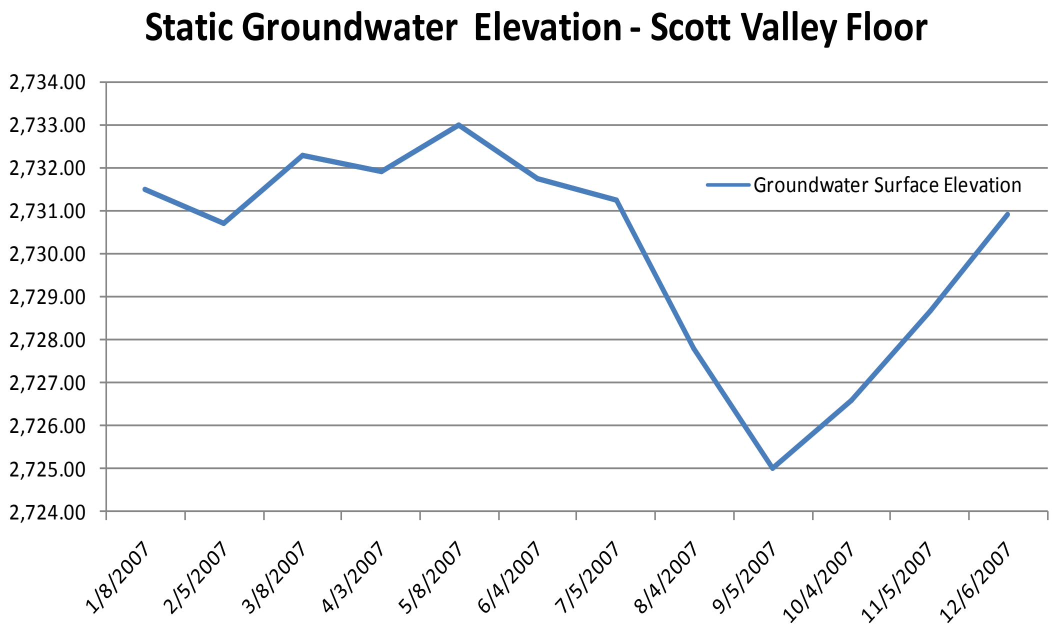


Figure 3 – The top graph depicts accumulated monthly flow (60 year average) at USGS gage Scott River below Ft. Jones and the bottom graph depicts the static groundwater elevation in a randomly selected well on the Scott Valley Floor

Altered stream channel and bank profile: Depth to low flow water table in regions of the main stem Scott River can be greater than ten feet, prohibiting the establishment of natural riparian recruitment and the success of non irrigated riparian plantings. Areas with levees along the stream banks can have land with elevations significantly higher than the water surface elevation of the adjacent river and underlying water table. Attempting to establish riparian vegetation in these lands that are adjacent to the stream but lack the essential year round water supply for hydrophilic plants could be an exercise in introducing plants into the incorrect ecosystem.

Browse by wildlife: Multiple species of wildlife (deer, elk, beaver, rodents, etc.) have browsed on the newly established riparian plantings. Use of fence cages has limited the amount of browsing by larger wildlife. Experience has shown that fence cages need to be established at the same time as the planting.

Competition with other vegetation: Some locations in which planting occurred were previously occupied by rhizomatous grasses (e.g., reed canary grass - *Phalaris arundinacea*) before execution of the restoration project. Some of these grasses were removed in the preparation of the site but quickly reemerged from the disturbed rhizomes. It is hypothesized that the grasses can quickly utilize the limited surface water supply and out compete the introduced plantings. An effective treatment to remove the grass previous to introduction of plantings is desired.

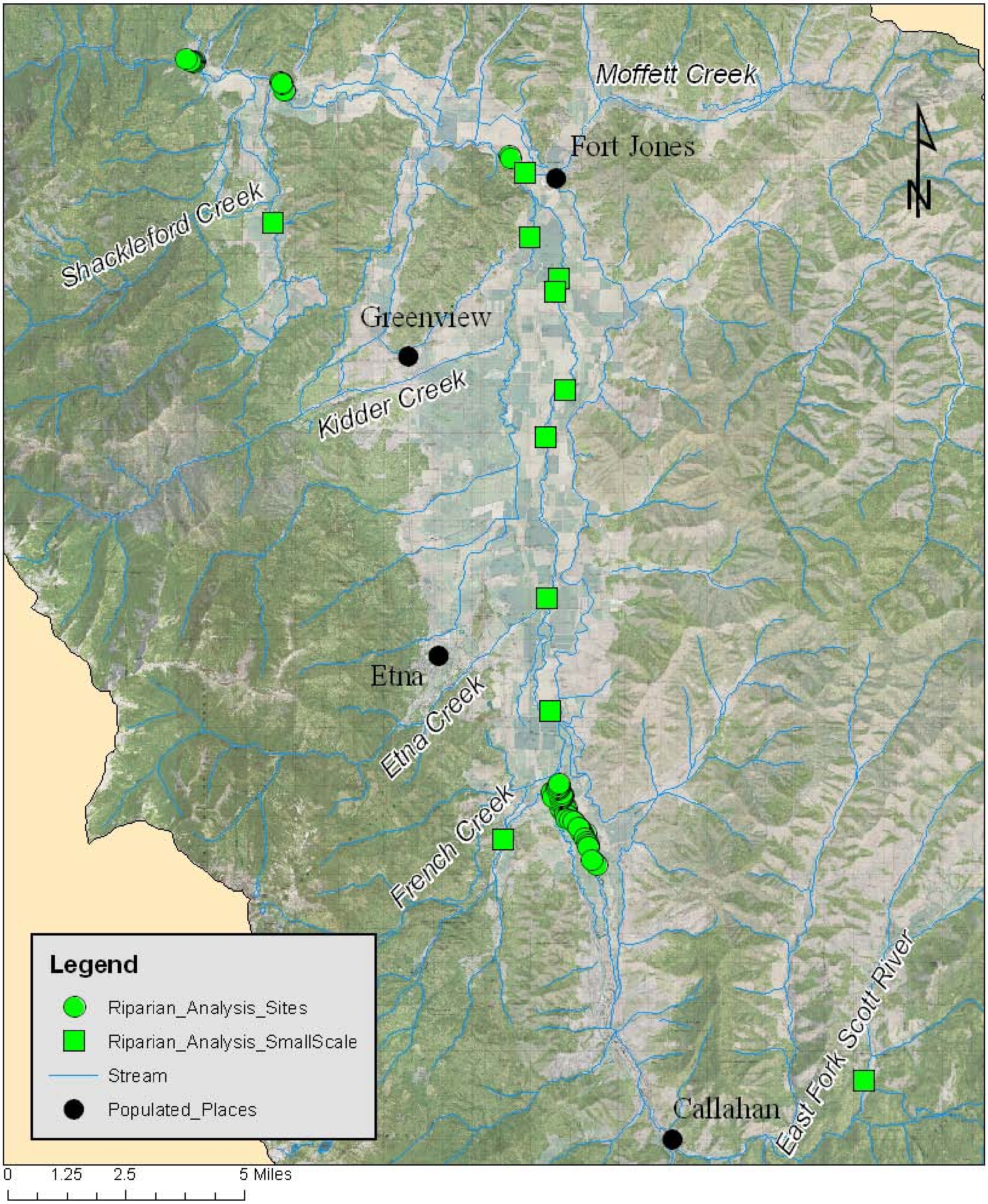
Chapter 4 – Inventory and assessment of past riparian projects
Methods

Compilation of supporting documentation on past riparian projects:

The first step in this Scott River Riparian Restoration Analysis was to compile specific information on all past riparian replanting efforts in the Scott River Watershed. Information gathered for each planting effort performed by the Siskiyou RCD includes: planting location, approximate acreage planted, year of planting, planting technique and species, and any maintenance method(s). This information for projects performed in a single location is summarized in **Table I Summary of Past RCD Riparian Restoration Projects** and projects with multiple spatially separate planting locations are further detailed in **Table II. Detailed summary of select projects.** See Map #1- Scott River Riparian Analysis Sites – 2007 - 2009 for locations inventoried.

Riparian replanting efforts analyzed for this project were established from 1992 to 2008. A variety of planting techniques were utilized and site conditions varied throughout the watershed. See **Appendix B** for results of site inventories completed in 2007-2009.

Scott River Riparian Analysis Sites - 2007-2009



Map 1 – Riparian restoration project sites that were assessed from 2007 - 2009

Before identifying locations to be inventoried, the main stem Scott River was evaluated for general differences in site conditions. Based on differences in soil condition (type), channel condition and the elevation difference between riparian landforms and the low flow water table, three broad main stem reaches have been identified (See Map #2 – Scott River riparian analysis – Main stem reaches). A table of river miles (RM) and river kilometers (RKM) for key features in the Scott River is available in Appendix D. Tributaries were group as a separate category in addition to the three main stem reaches. A subset of past projects in each reach was inventoried.

1.) Tributary locations -

Soil types in tributaries are varied. However, many of the planting locations are in alluvial sections that have higher quality soils. Due to the riparian corridors closer proximity to the active channel, the elevation of the water table at planting locations was more consistent throughout the dry season than some main stem sites. Tributary locations with year round flows (e.g., French Creek below Miners Creek and above the Highway 3 Bridge) currently have areas with mature riparian forests in good condition. The potential for natural recruitment in these tributaries is high in areas protected by riparian exclusion fencing. Reaches of the tributaries that do not have year round flow (e.g. Kidder Creek above and below the Highway 3 Bridge) are currently limited in the density and distribution of riparian plantings.

2.) Scott River - Callahan to the end of tailing piles - RM 57.1 – 52.1

This is a reach predominated by areas with tailing piles on both banks of the river with limited occurrence of riparian vegetation along much of the bank. Some areas have near vertical banks of tailing piles directly adjacent to the river's active channel with no potential for riparian recruitment or introduction without extensive landform alteration. Due to the limited potential for riparian planting success this reach has not been treated in any of the past projects and was not included in the prior riparian analysis.

3.) Scott River– end of tailing piles to Youngs Dam - RM 52.1 – 46.7

The Scott River from the end of the tailing piles to Youngs Dam (the SVID diversion structure) is a reach defined by a wide floodplain and riparian zone and a relatively shallow water table. All locations in this reach with livestock pasture adjacent to the stream have had exclusion fencing in place for over a decade.

The west side of this reach has considerable influence from west side perennial streams (*e.g.*, Sugar Creek, French Creek and Wolford Slough). Surface and subsurface flows from these streams likely contribute to a relatively high water table in summer. Stream channel cross-sections taken on the Scott River at Wolford Slough (June 2009) indicate that ground surface elevation on the adjacent terraces is 4-7 feet above the thalweg of the Scott River, which should roughly correlate with the base flow water table. This corroborates observations during previous planting efforts that indicated the water table was 4-7 feet below the ground surface elevation (Gary Black 1998). See detailed write up of cross section elevations at end of chapter**.**

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 200 to 1,000 ft with an average of 600 ft. The available riparian zone is identified as the area between riparian exclusion fencing and the stream bank. The smallest width of available riparian habitat is in the last downstream mile of this reach. Many of the locations analyzed have in excess of 300 feet of fenced riparian or floodplain on one side of the river with several locations having 500 – 700 ft available. This reach has the widest fenced riparian and floodplain land in the main stem Scott River.

3.) Scott River - Below Youngs Dam (SVID) to Moffettt Creek - RM 46.7 – 31.8

A large portion of this reach of the Scott River was "straightened, cleared and leveed" by the Army Corp of Engineers in the late 1930's. Many areas of stream bank that were actively eroding following the 1955 flood event have been stabilized with large rock rip rap. Several areas of successful riparian and non-riparian plantings were introduced by the Soil Conservation Service through this reach.

This reach is characterized by limited flood plain connectivity with the majority of the land adjacent to the active channel comprised of leveed stream banks. Riparian planting sites were mostly at or above the elevation of the adjacent field (e.g. top of levee), soil characteristics vary but soils are mostly comprised of gravel and cobble substrate which does not hold moisture in the dry summer months. Based on observations recorded in contract final reports and observations in the field it is estimated that ground surface elevations on the adjacent terraces is between 8-11 feet above the low flow surface and groundwater elevations.

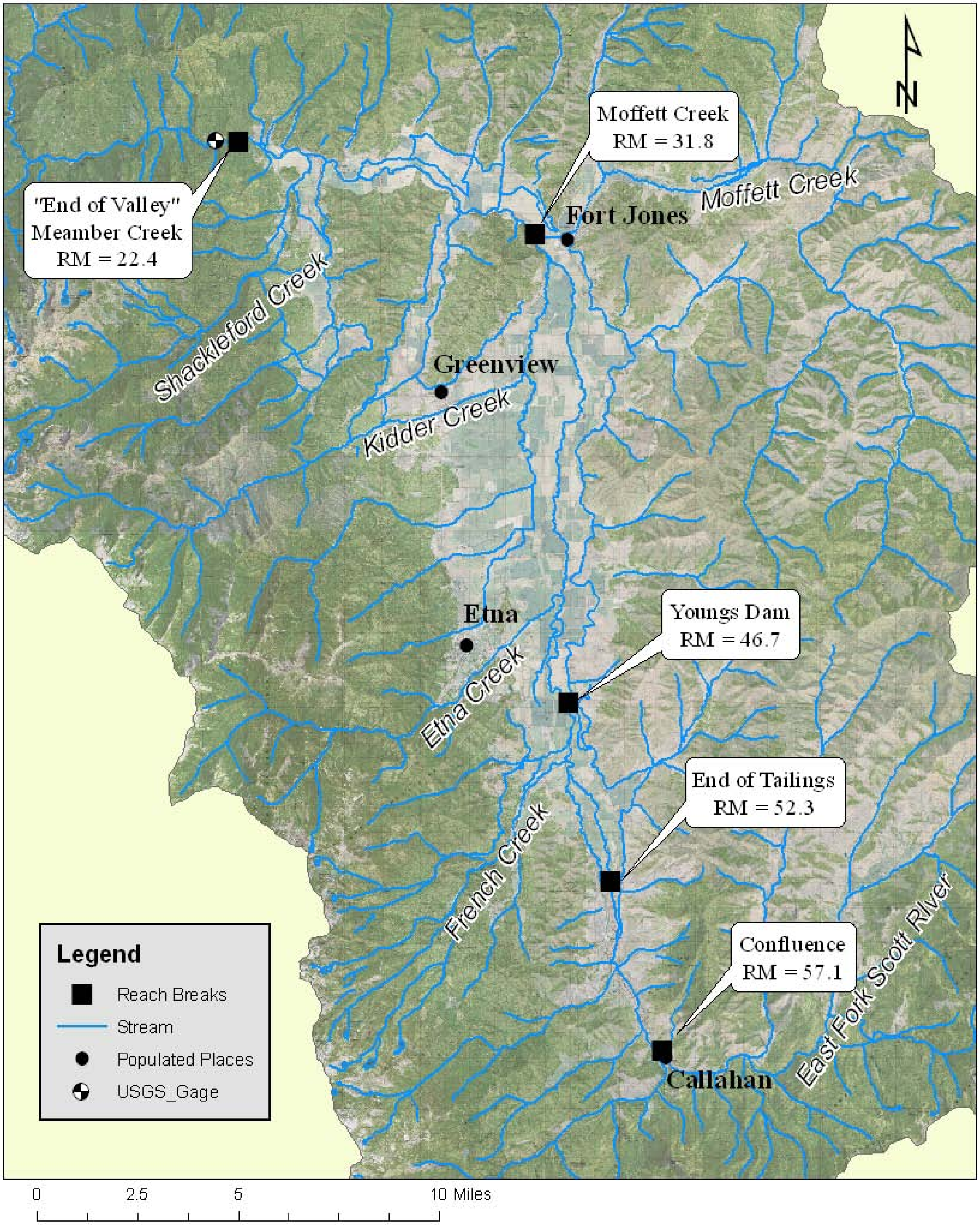
Cross section data collected at Etna Creek shows that the depth to water may be 5-7 feet in a normal year, but in a year such as 2001, greater than 10 feet.

Most historic planting sites are currently barren of introduced trees with only perennial grasses and weeds present. It is hypothesized that the invasive rhizomatous perennial grasses observed in many locations throughout this reach were a significant competition to past riparian planting efforts. Determination of viable eradication and/or control methods to remove these grasses at sites of future riparian planting is desired.

Etna Creek provides only subsurface flows in the summer months, Patterson, Johnson, and Crystal Creek combine to form the Big Slough. Big Slough joins Kidder Creek to the east of Greenview and Kidder Creek joins the Scott River upstream of the confluence with Moffettt Creek. The affects on the groundwater elevation from the major tributaries to the west of the Scott River in this reach is largely unknown.

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 70 to 1,000 ft with an average of 350 ft. The upstream end of this reach has a greater width of riparian and floodplain land on average compared to the downstream end. A stretch of the Scott River approximately 3 miles long (centered on RM – 34.4) has an average of less than 110 ft of combined available land on both sides of the river. This reach has the smallest average width of available land adjacent to the stream for riparian planting and potentially has the greatest distance from "riparian" landforms to the low flow surface and groundwater elevations.

Scott River riparian analysis - Main stem reaches



Map - #2 – Main stem Scott River reach breaks and select major tributaries

4.) Scott River from Moffett Creek to below Meamber Creek (RM 31.8 – 22.1)
This reach has some similar characteristics to the reach from below Youngs Dam to Moffett Creek but does not have an area of restricted riparian availability and high elevation levees. This reach of the Scott River is dominated by gravel and cobble throughout the stream banks and adjacent flood plains. Historic planting sites varied from sandy loam to high gravel bars. The distance to groundwater at the planting sites is estimated to be greater than 10ft in many locations. Levees are not as prevalent in this reach as upstream and it is hypothesized that the difference between landform and low flow surface and groundwater elevations is not as severe as observed in some locations upstream. Analysis of historic plantings demonstrates mixed results with some locations showing moderate to good success and other locations with limited success.

Shackleford and Oro Fino Creeks enter this reach of the Scott River from the south and Indian, and Rattlesnake Creeks enter from the north. All of these tributaries are dry during the summer months at and above the confluence with the Scott River. There is very little to no riparian vegetation along these dry reaches of the tributaries.

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 125 to 1,000 ft with an average of 550 ft. The available width for riparian planting is uniform throughout the majority of the reach with only a few locations in which the combined available width is less than 300 feet.

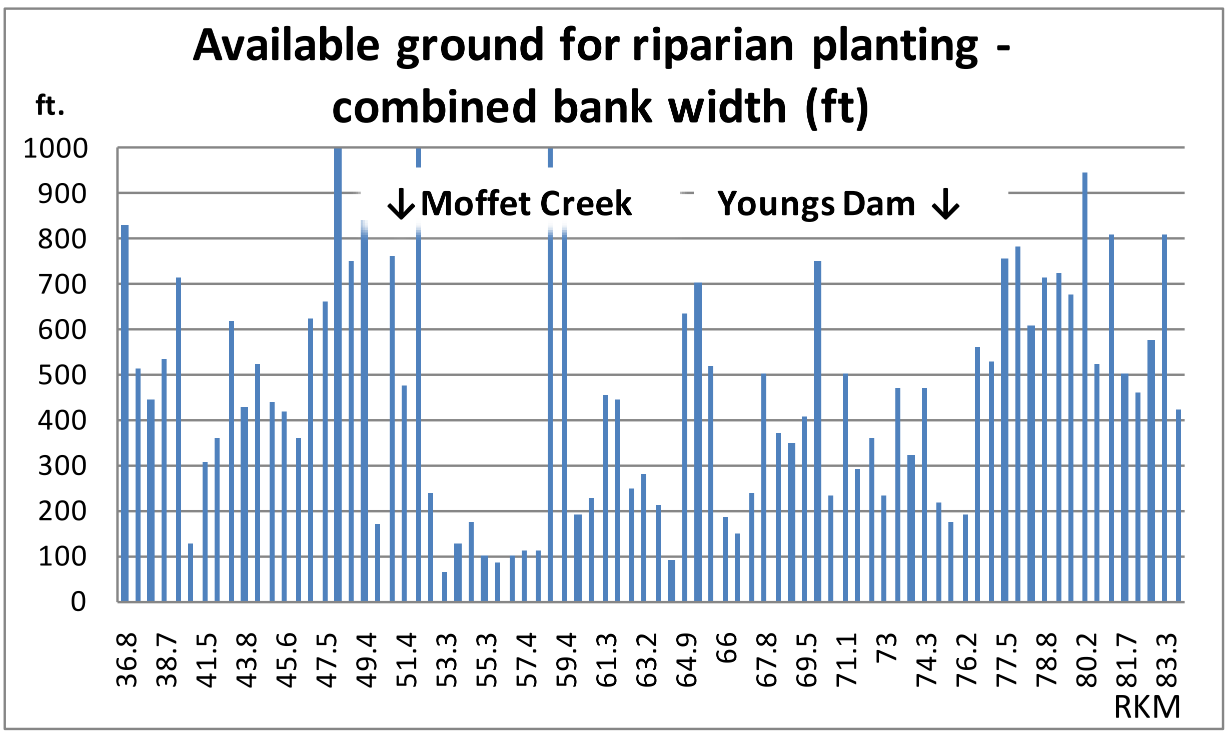


Figure 4 – Available combined width for riparian planting – both banks combined

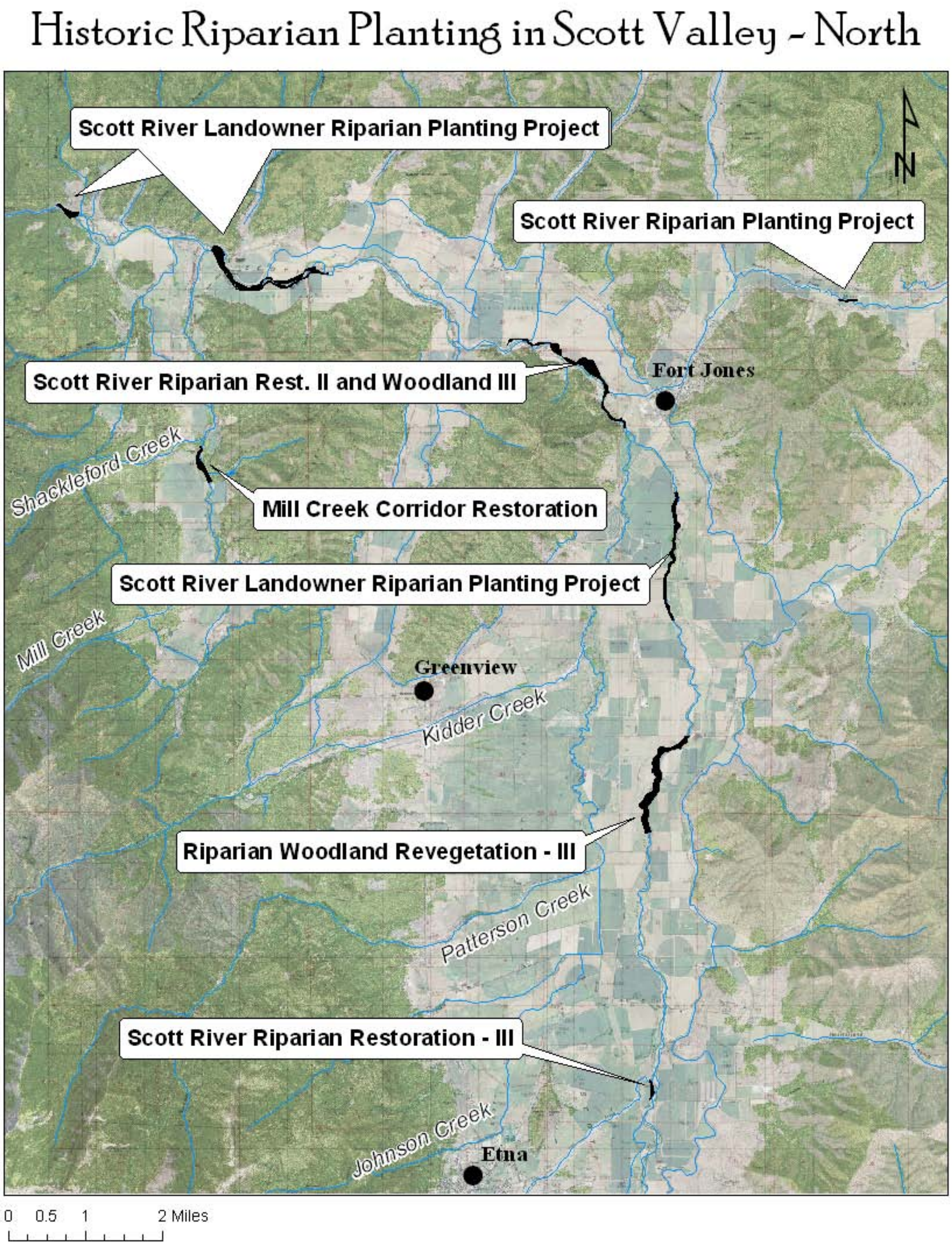
Table I-Summary of Past RCD Restoration Projects

Project	RCD #	Year of Planting	Location	Site Description	Species	Acres	density	intent	planting technque	Maintainence	Conclusions from contract final report
Scott River Riparian Fencing Planting II	61	1995	Pastures of Heaven								
Riparian Woodland Revegetation II	See Sheet 3	1995	Scott	See Table II	Pacific or yellow tree willow (Salix lucida ssp lasiandra) Arroyo willow (S. lutea) Black Cottonwood (Populus trichocarpa) Ponderosa Pine (Pinus Ponderosa)	27.5					
Cal-forest	63	1997	Scott	See Table II	willow, alder, cottonwood, pine	58			rooted stock on drip line, dormant stock w/out fully	mulch and cardboard shade boards	
RCD	63	1997	Scott	See Table II	Pacific willow, Arroyo willow, Cottonwood	14	150-210		Pole stock planted 4-6'deep		
French Creek Riparian Woodland Revegetation	67	1997	Opposite Confluence of French Cr. And Scott River		Pacific or yellow tree willow (Salix lucida ssp lasiandra) Arroyo willow (S. lutea) Narrow leaf willow-Sand Bar (S. exigua) Black Cottonwood (Populus trichocarpa) White Alder (Alnus rhombifolia) Ponderosa Pine (Pinus Ponderosa)		473	restore riparian condition following flood of 1997	plug stock of all, and willow whips	Drip irrigation of non-dormant stock through summer and fall. Soil sites watered once a week. Sand and gravel sies watered 2-3 times, or continuously.	1.) Planting timing should be mid March - mid april for dormant stock, late-april to mid- may for non-dormant 2.) Mulching is essential in areas of heat stress 3.) allow plants to dry between watering to promote vertical root growth
Center Bar	67	1997		unconsolidated cobble, gravel, sand		11		restore riparian condition following flood of 1997	plug stock of all, and willow whips	Drip irrigation of non-dormant stock through summer and fall. Soil sites watered once a week. Sand and gravel sies watered 2-3 times, or continuously.	1.) Planting timing should be mid March - mid april for dormant stock, late-april to mid- may for non-dormant 2.) Mulching is essential in areas of heat stress 3.) allow plants to dry between watering to promote vertical root growth
French Cr. Bar	67	1997		entirely DG		4		restore riparian condition following flood of 1997	plug stock of all, and willow whips	Drip irrigation of non-dormant stock through summer and fall. Soil sites watered once a week. Sand and gravel sies watered 2-3 times, or continuously.	1.) Planting timing should be mid March - mid april for dormant stock, late-april to mid- may for non-dormant 2.) Mulching is essential in areas of heat stress 3.) allow plants to dry between watering to promote vertical root growth
Mill creek Corridor Restoration	58	1998	Mill Creek	higher eleveation w/poor soil condition	Pacific willow, Arroyo willow, Black Cottonwood						
Scott River Riparian Restoration I	63	1998						Establish a riparian area			
Scott River Corridor Habitat Improvement	64	1998			Golden willow, Arroyo willow, Red willow, Black cottonwood, Pondersa Pine, alder.			Use of riparian planting to stabilize stream banks.	willow baffle and debris jams Willow and cottonwood Baffle: rooted stock and pole cuttings(at least 4	yes	Success with pole plantings,68% on rooted stock after two seasons.
Riparian Woodland Revegetation I	81	1998									
Scott River Restoration II	81	1998	5.0 miles of stream south of the mouth of Etna Cr.		Pacific willow, arroyo willow, red willow, black cottonwood	36		Improve and estend riparian and cold water habitat throughout a 5 mile section of Scott River.	Pole cuttings 3' in diameter and 12-14' long, back-hoe planting to reach estimated summer water table. Tips cut down to only 1 foot.	Mulch, shade cards, and browse cages where necessary	See Sheet # 3
Scott River Corridor Enhancement Project	87	1998	Eller Lane	Eller Lane downsteam to Hansen Property	cottonwood, willow, pondersa pine	10	Unkown	increase channel diversity and devleop riparian zone	irrigated stock	irrigation	
Scott River Landowner Riparian Planting Project	80-1	1998	Various - Sheet 3	See Table II	Pacific willow, Arroyo willow, Black Cottonwood	11.5	150-210	Establish a riparian area.	Back-hoe digging to estimated water table. Ple cuttings ~2.5" in diameter uo to 12' long.	None	
Shackleford-Mill Corridor Improvement Project	56	1999	Mill Creek			0.75					Natural reveg of alder, red willow, pacific willow, black cottonwood and pine, sedges and annual grasses, after 10 mo of exclusion fencing.
Scott River Riparian Restoration III	60	1999/2000	Scott R. near Etna Cr.	upstream from the mouth of Etna Creek	willow	14	200 total	establish a riparian to stabilize eroding bank		deer browse cages	excessive deer browse, 80% survival
Riparian Revegetation III	95-III			See Table II	Alder, cottonwood, Maple, Pine , Willow	32.8					
Scott River Enhancement Project	77	2000	Scott River downstrea m from SVID			11		re-establish a functioning riparian zone and reduce channel width.	pole cuttings	some caging and watering, but pump was out of order for over a month.	drought and deer browse affected the plantings.

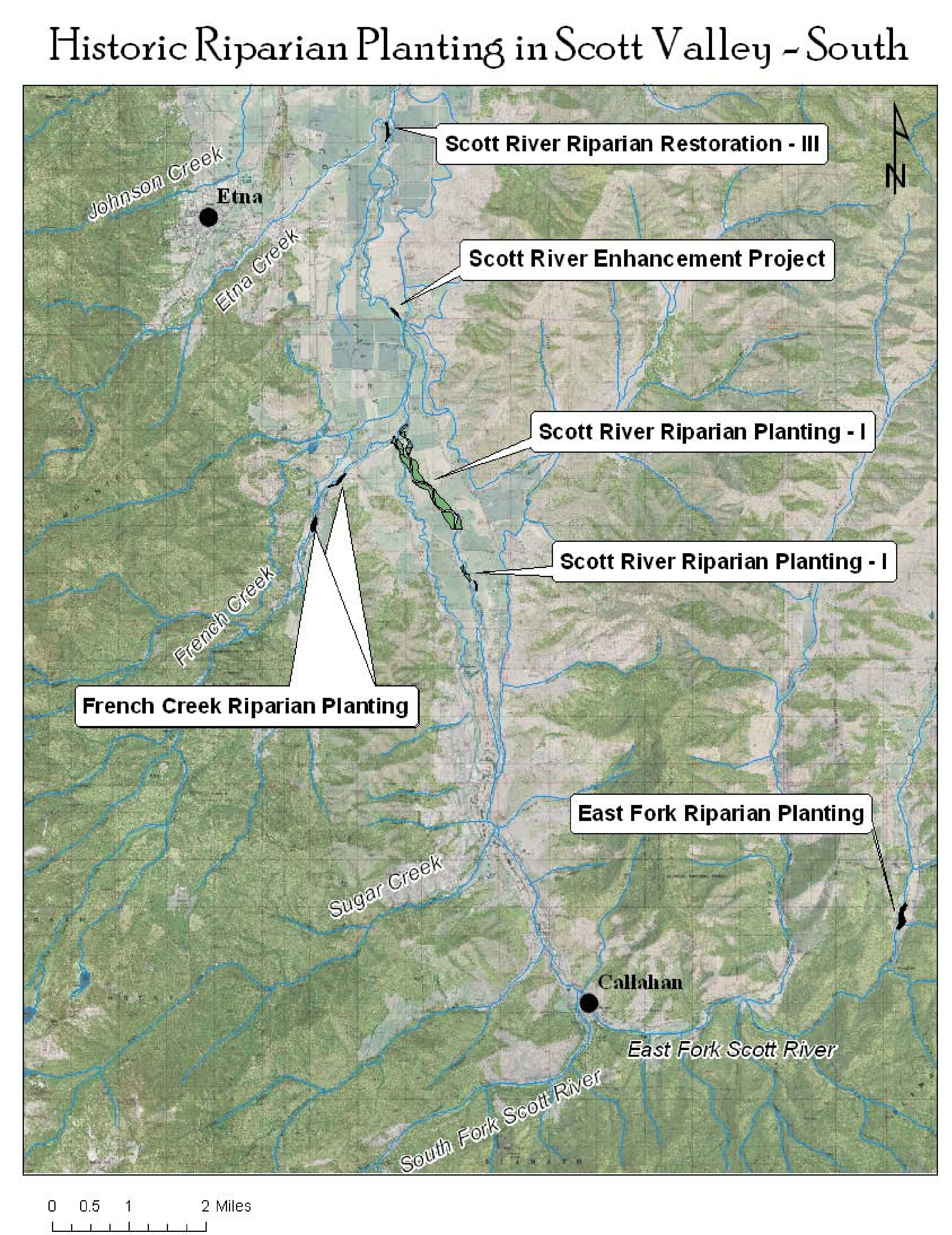
Table I (cont.) -Summary of Past RCD Restoration Projects

Project	RCD #	Year of Planting	Location	Site Description	Species	Acres	density	intent	planting technque	Maintainence	Conclusions from contract final report
Scott River Landowner Riparian Planting Project	80-2	2000	Various - Sheet 3	See Table II	Pacific willow, Arroyo willow, Black Cottonwood	10.5	150-210	Establish a riparian area.	Back-hoe digging to estimated water table. Ple cuttings ~2.5" in diameter uo to 12' long.		
East Fork of the Scott River	83	2001	Lower Masterson Rd	East Fork Scott River near Grouse Creek. Site has been used for mining and agriculture for over a century. Banks were eroded prior to stabilization.	Willow and black cottonwood	8			Pole cuttings . 3-8 feet to water table.	All plantings mulched, some covered for shade.	drought year heavily impacted plantings
Finley Ranch Enhancement	75	2002	Kidder Cr. Slough(.4 miles below Serpa Lane Bridge		Ponderosa Pine and Willow?			Establish a riparian zone by providing an overstory riparian community along a reach of the Scott R. and Kidder Creek.	Large stock planted to approximate estimated summer water table depth. Wheel-line irrigation	deer browse protection & wheel line irrigation	91% after one season
Scott River	75	2002				2.5	160-220				
Kidder Slough	75	2002				5	160-220				
Kidder Creek Enhancement Project	37	2003	Lower Kidder Slough	1.1 miles of stream, plantings on both sides	Pacific willow, red willow, black cottonwood, ponderosa pine	5	160-210		4-10 foot deep trenches with 4-5 feet of plant above surface	wire cages (60%)	beaver activity impacted 30% of the uncaged trees. Replanted the west side in 2004, caged all plantings. All livestock removed permanently prior to plantings. Deer browse did not impact plantings.
French Creek Riparian Restoration Project	46	2003	French Creek	Abv Hwy 3 to Miners Creek	Pacific, Arroyo willow, black cottonwood, Ponderosa Pine	5.5	260-500	Expand existing riparian width, develop contiguous riparian vegetation	Large cuttings trenched to low flow water table.	Winter wheat planted for shade, mulch, browse cages	
Scott River Enhancement Project	77	2003		planting at instream area	Arroyo and golden willow, Black Cottonwood and Ponderosa Pine	1.5	350 total	re-establish a functioning riparian zone and reduce channel width.	pole cuttings	cage and irrigation with water truck	none
Scott River Landowner Riparian Planting Project	80-III	2003	See Table II	See Table II	Various - Sheet 3	6		establish riparian in selected areas	Back-hoe digging to estimated water table. Ple cuttings ~2.5" in diameter uo to 12' long.	2,300 feet of fencing	Good growth, deer browse continues to be a problem, 50% 2005
Kraus Bank Stabilization	92	2006	Moffet Creek		willow and cottonwood	N.A		Planting streambank stabilization structures			
Owens East Fortk Stabilization	97	2006	East Fork		willow and cottonwood	N/a		Planting streambank stabilization structures			
French Creek Drainage Protection & Enhancement Project	46-2	2006	French Creek	Stapleton/Tobia		2	Tobias 150-220				
French Creek Drainage Protection & Enhancement Project	46-3	2008									

Map Existing Riparian protection and restoration projects



Map #3 – Historic planting locations in North Scott Valley



Map #4 – Historic planting locations in South Scott Valley

Inventories of current riparian condition

During the summers of 2007 and 2008 RCD staff visited a subset of all previously completed riparian restoration projects to assess the survival of plantings and evaluate which planting techniques were most successful. See **Appendix B- Riparian Planting Inventory Results** for detailed site specific information.

Methods

Sub inventory Technique

For smaller scale planting sites, the site was assessed for survival and relative health of plantings. Small scale sites are defined as those which were less than an acre, or which were narrow strips of planting following the river bank. Photographs were obtained at each site to document the current state of the riparian plantings and any potential naturally recruited vegetation.

For larger planting sites, such as the Cantara riparian planting, a series of representative 0.1 acre plots were surveyed using the following protocol. Each planting block was sampled at three to five representative 0.1 acre circles. A circle with a radius of 37.5 ft was delineated in the selected locations of each planting block. The location of each sampled location was captured with hand held GPS. The trees within the circle were counted and classified by height and recorded on a datasheet. Photographs of each sub-sampled location were obtained.

Selection of sites for Sub inventory

Based on the categories identified in Task 1, and site conditions (soils, water table, competing vegetation, etc) locations were selected for one time inventory during the summers of 2007 and 2008. The results of the inventory for each site are presented in **Appendix B.** The original intent was to inventory a sub-set of all projects in each reach. However, planting efforts in the Scott represent different approaches and methodologies in planting techniques. In this inventory, effort was made to inventory sites in each reach that represent all the planting methods utilized in that reach. The following summarizes the inventory results:

Tributary Locations: All planting locations on tributaries were inventoried with the exception of a site on Kidder Creek that completely washed out in 1997 and a site on McAdams Creek.

Main stem locations: Multiple project sites in each of the three main stem reaches were inventoried. The intent was to inventory sites representing different planting techniques and different landscape and channel conditions.

Tables III-a – III-d summarize the results of the site inventories. The following definitions are used in the evaluation of past planting projects:

Failure- no planted vegetation remains

Success- some amount of planting stock remains with good growth (*e.g.*, tree heights greater than 10 ft) observed.

Natural Recruitment- Site has had natural recruitment of vegetation since original planting effort.

Partial success-some planted stock remains but growth is poor.

Table III-a - Tributary Locations

Stream	Site Description	Inventory Result	Conclusion
Kidder Creek	Kidder Creek between Serpa Lane and Hwy 3	Successful - Cattle Exclusion in place	
Kidder Creek	Scott River Riparian Woodland Revegetation II.	Site not inventoried	Washed out in 1997 flood
Mill (Shackleford)	Mill Creek above the confluence with Shackleford. Current presence of beaver dam.	Successful with significant natural recruitment - cattle exclusion in place	This site appears to experience a very stable water table and natural recruitment was more successful than the plantings following cattle exclusion.
French Cr.	Below the Miners Rd bridge to the Hwy 3 Bridge	Partial success	Subject to deer browse
French Cr	Above the Miners Rd Bridge (north side)	Success after one year of growth	Utilized browse cages
Etna Creek	South side of Etna Creek at the confluence with the Scott.	Failure Poor soil and groundwater conditions.	Aggressive maintenance with browse protection and irrigation.
East Fork Scott	Upstream from Grouse Creek to above Masterson Road Bridge	Partial Success with natural recruitment. Livestock damage and 2001 drought stress.	Natural recruitment with more success likely if livestock excluded. This reach experiences accretion flows.

Table III-b Scott River mainstem above Youngs Dam (SVID).

Stream	Project		Notes
Above Fay Lane-Barnes	Scott River Riparian Restoration I (Cantara)	Success with natural recruitment	Replant to expand/enhance existing riparian vegetation
Tobias	Scott River Riparian Restoration I (Cantara)	Success with natural recruitment	Replant to expand/enhance existing riparian vegetation
Spencer	Scott River Riparian Restoration I (Cantara)	West-side success, East side failure	Replant west side to expand/enhance existing riparian vegetation

Table III-c Scott River Between SVID and Moffett Creek

Stream	Project	Inventory Results	Conclusion
Scott River below Black Bridge – Sharps Gulch	Scott River Riparian Woodland Revegetation III. (#95)	Failure	Failure potentially due to unintended cattle grazing, discontinuation of irrigation and competition with grasses.
Scott River below Black Bridge	Scott River Riparian Woodland Revegetation III (#95)	Partial success	Suitable for planting pine or cottonwood. Used irrigation and deer browse protection.
Scott River around Etna Creek	Scott River Riparian Restoration II (60)	Failure	Potential reasons for failure include: deer browse, drought and depth to water table.
Scott River directly below Youngs Dam	Scott River Enhancement Project (#77)	Partial success	Irrigation system failure and period of drought
Scott River upstream of Serpa Lane	Planted by Alvin Lewis – Soil Conservation Service	Success	Intensive irrigation of golden willow and cottonwood – one of the most successful plantings
Scott River below Moffettt Creek	Landowner Enhancement Project (#75)	Partial success	Need to evaluate depth to water table – deer browse and drought potentially limited initial success.

Table III-d Scott River from Moffett Creek downstream.

Stream	Project	Inventory Results	Conclusion
Scott River below Moffettt Creek	Just downstream from Moffettt Creek (Eiler)	No survival, drought and flood	
Scott River below Moffettt Creek	Eiler Ranch	Failure	Planting on gravel bars failed due to "high and dry" condition of bars
Scott River below Moffettt Creek	Main stem Scott one mile below Moffett Cr.	Failure	
Scott River above Meamber Bridge	Scott River Landowner Riparian Planting Project (80-II)	Not inventoried due to lack of access	
Scott River above Shackleford Creek	Below Meamber Bridge above Shackleford Creek	Success with natural recruitment	Willows/cottonwoods, good condition
Scott River below Shackleford Creek	Below Meamber Cr. Above USGS	Success - willows and cottonwoods in good condition	Landowner performed irrigation and maintenance are keys to success

Riparian site inventory Discussion

Tributary Locations

Planting efforts in tributary locations have been both successes and failures. One of the most successful sites surveyed was in Mill Creek (Quartz Valley) in which cattle exclusion fencing was combined with riparian plantings and natural recruitment to create an area with a robust riparian forest and significant beaver dam and impoundment. This area and other tributary locations above the alluvial fan appear to maintain a relatively stable water table. Tributary areas outside of the aggraded alluvial fans typically have some existing vegetation that helps to create a micro-climate that shelters the plantings during establishment and are an essential source for natural recruitment. Locations with stable channels and water tables that will potentially support introduced plantings include: French and Miners Creek, Mill Creek (Shackleford) and the lower reaches of the South Fork Scott River. Some of these locations have current riparian areas that do not require restoration and serve as potential sources for natural recruitment and stock for future riparian planting efforts. Locations in the alluvial fans (Kidder Creek, Lower Etna Creek, Patterson Creek and the mouth of Shackleford Creek) are subject to the same challenges that main stem sites have, including: significant fluctuations in depth of water table, lack of flood plain connectivity, potential lack of natural recruitment and higher potential for significant stream channel erosion. The introduction of cattle exclusion fencing in areas with grazing adjacent to the stream is an essential first step in any attempt to protect and/or enhance the riparian corridor.

Successful riparian plantings –

Mill Creek and French Creek have had some of the most robustly successful riparian planting efforts. In these locations, the naturally stable water table and existing riparian vegetation have aided in the establishment of a healthy riparian corridor. A project to that introduce fencing and plantings in Mill Creek after the 1997 flood serves as an example of the most successful effort to date.

Mill (Shackleford) Creek: This was the site of streambank stabilization, cattle exclusion fencing, and riparian replanting completed in 1998 and 1999. Analysis of aerial photographs of the planting location in 1993 and 2005 demonstrate a significant increase in riparian vegetation within the fenced area (Figure 5). A large beaver dam and associated impoundment has been observed in this area of Mill Creek since 2005.

This 15.3 acres site on Mill Creek was a major riparian restoration project started in 1998 and completed in 1999. The stream channel was re-profiled and stream banks were protected and stabilized with large rock armor. Cattle exclusion fencing was installed on the .7 mile reach with an average of 450 feet between fence lines. A small amount (.75 acres) of riparian replanting was completed within the fenced area adjacent to the active channel. In addition to the planted vegetation, after just 10 months of cattle exclusion fencing significant natural recruitment was observed in this reach. Naturally recruited vegetation include: alder, red willow, pacific willow, black cottonwood, ponderosa pine, sedges and annual grasses.

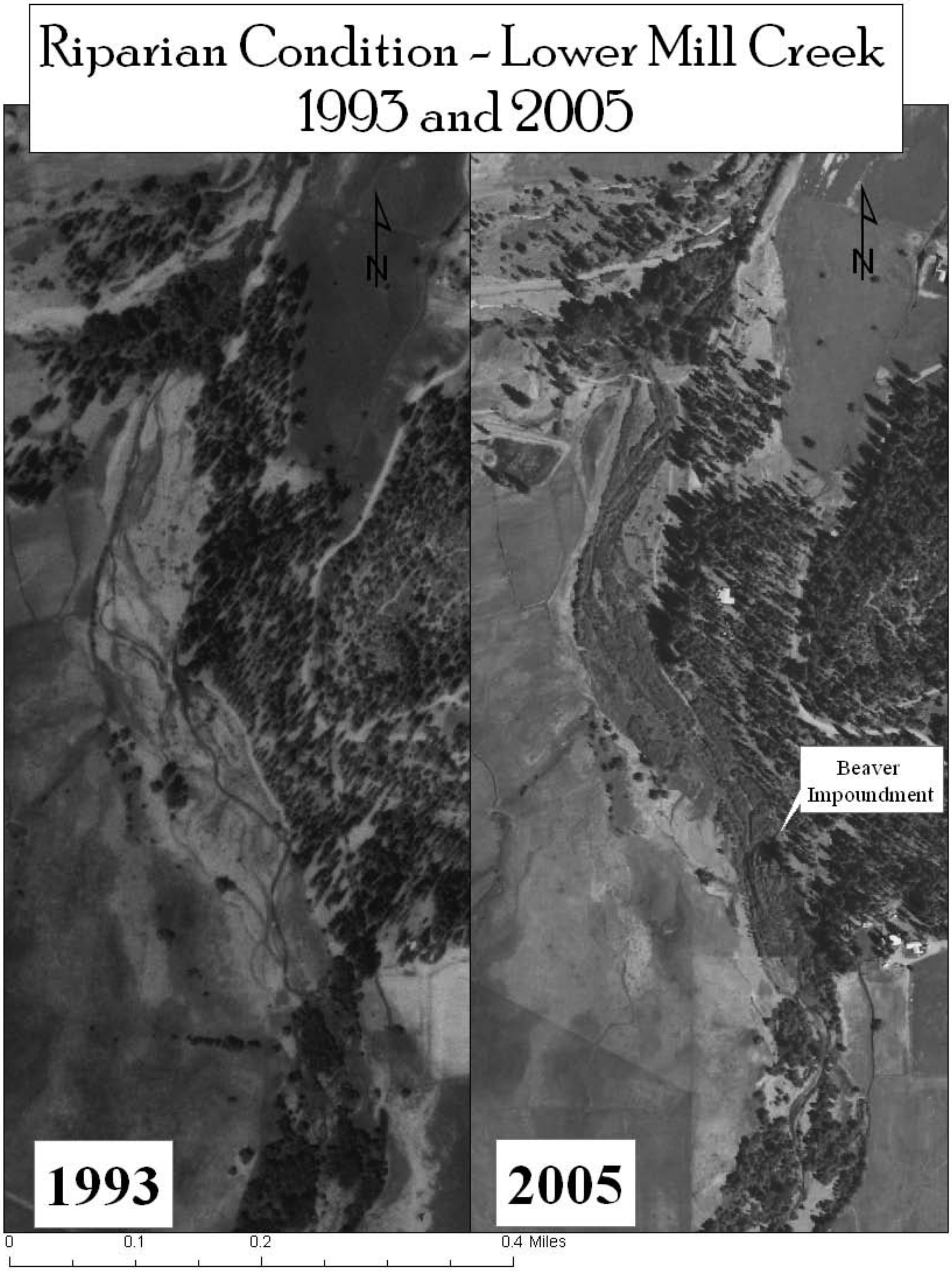


Figure 5 – Aerial images of the same reach of Mill Creek in 1993 (left) and 2005 (right).

The image above clearly illustrates the current (2005) extent of riparian vegetation in the project reach in contrast to the almost denuded state of the channel's banks and floodplain in 1993. A beaver dam and significant impoundment currently exists in the upstream portion of this reach.

No indication of beaver presence is observable from the 1993 aerial photograph. It is hypothesized that the increased riparian vegetation allowed the beaver to create a dam that impounds the creek effectively increasing the water table in the area and supporting further riparian growth. Besides the positive effect on riparian vegetation the beaver dam's impoundment has been documented to provide habitat for rearing juvenile coho salmon and rainbow trout.

Figure 6 This picture shows the completed fencing and riparian planting in 1999 - Mill Creek on left

Figure 7 This picture shows the same exclusion fence on Mill Creek, December 2008 - Mill Creek on left – overflow from beaver impoundment in foreground

Figure 8 This picture shows natural vegetation within the fenced riparian area after 10 months - 1999

The success of this site is attributed to combination of the cattle exclusion fencing in a reach with a stable year-round water table and the existence of a source riparian seeds above and within the reach.

Figure 9 Impoundment behind beaver dam in Mill Creek, December 2008.

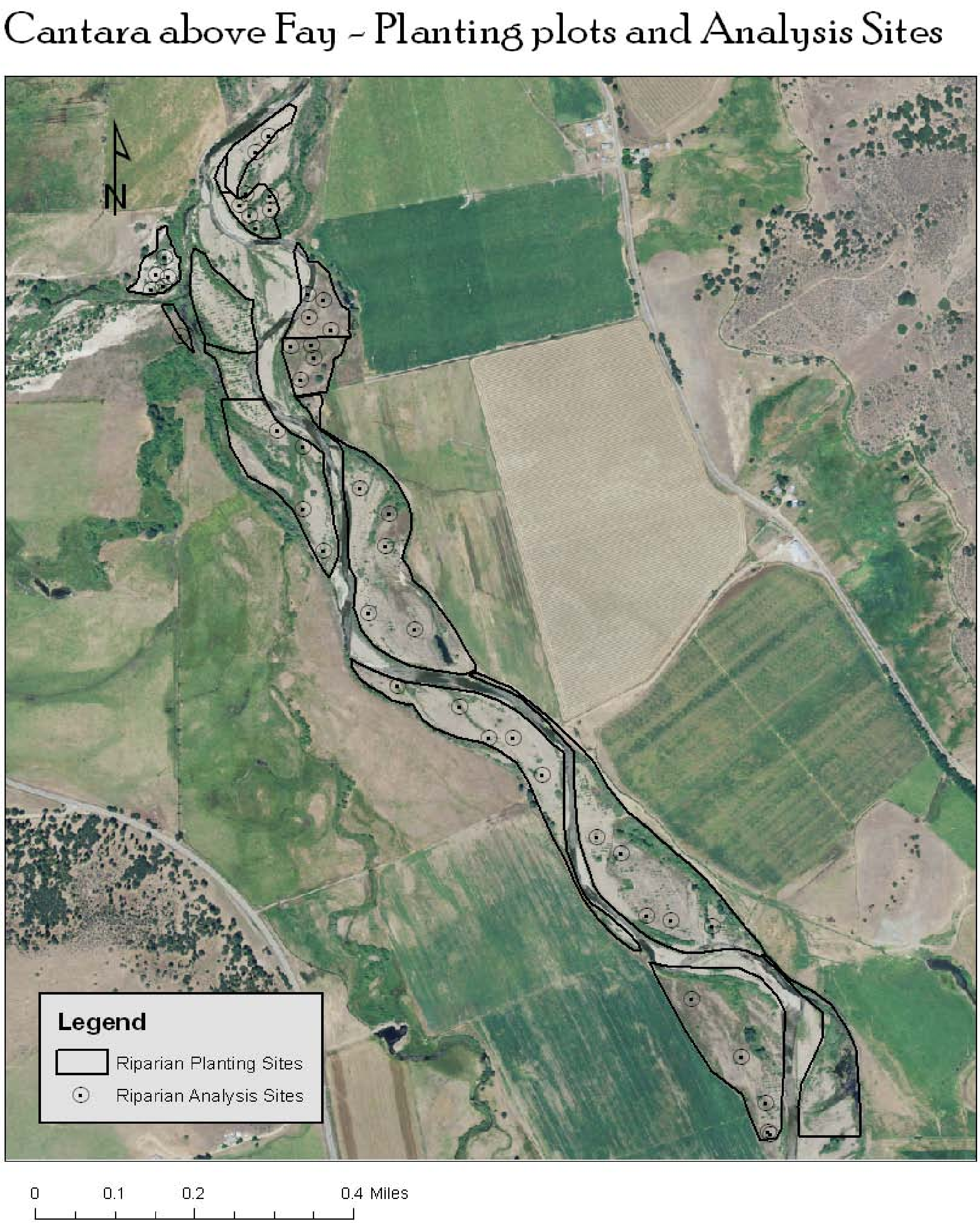
Figure 9 shows a view of the beaver dam from the west bank. The dam provides a stable water table year round that is ideal for riparian plants and rearing anadromous salmonids.

Additional examples of tributary plantings can be found in **Appendix B- Riparian Restoration Site Inventory.**

Scott River Mainstem

<u>Scott River mainstem above Youngs Dam (SVID)</u>.

The first large scale effort to implement riparian planting efforts in the Scott River was in this reach. A total of 100 acres adjacent to the Scott River from French Creek to above Hwy 3 were planted in 1997 and 1998.This area had significant channel alignment alteration during the flood of 1997 and was dominated by barren gravel bars before restoration efforts. This project is generally referred to as the Fay Lane project or the Cantara site. The full extent of the planting effort was from below the confluence of French Creek upstream to above Fay Lane Bridge -See Map 5 Cantara Planting and Analysis Sites. At these sites the planting technique was primarily rooted stock with irrigation for up to three years with some live cuttings placed into excavated trenches. Plantings done in 1997 were partially wiped out by the 1997 flood. Some sites were replanted in 1998. Plantings on gravel bars were subject to cambium burn from heat reflected from the exposed substrate. There are plantings surviving at nearly all of the planting sites with the exception of a couple plots on the east side of the river that are currently barren.



Map #5 – Cantara plantings and analysis sites

Successful sites: Plantings at the mouth of French Creek between French and Wolford Slough were the most successful (Figure 10). This is potentially attributable to a higher water table with less annual fluctuation due to the subsurface water contributions from the two streams.

Failed sites: Plantings directly across the Scott River from Wolford Slough (e.g., Osprey Site) were a complete failure (Figure 11). This location's soil is primarily composed of gravel and cobble, with poor water retention and no protection from solar radiation. This site was planted with rooted stock and irrigated with drip line for a period subsequent to planting. The site is currently vegetated with sparse willows and severely stunted pine trees with grasses covering a portion of the ground. The exact reasons this site failed are unknown but it is hypothesized that a combination of extreme local heat on the barren bar, limited availability of water during the low flow period and poor soil conditions limited the success of the plantings. It is unknown if extensive irrigation and protection maintenance would generate success in this location. There is currently no riparian vegetation to create a shaded and cooler micro-climate during the summer months to aid the success and survival of introduced plantings. Protection measures (e.g., cages with shade cards and mulch) might create the desired micro-climate around each plant.

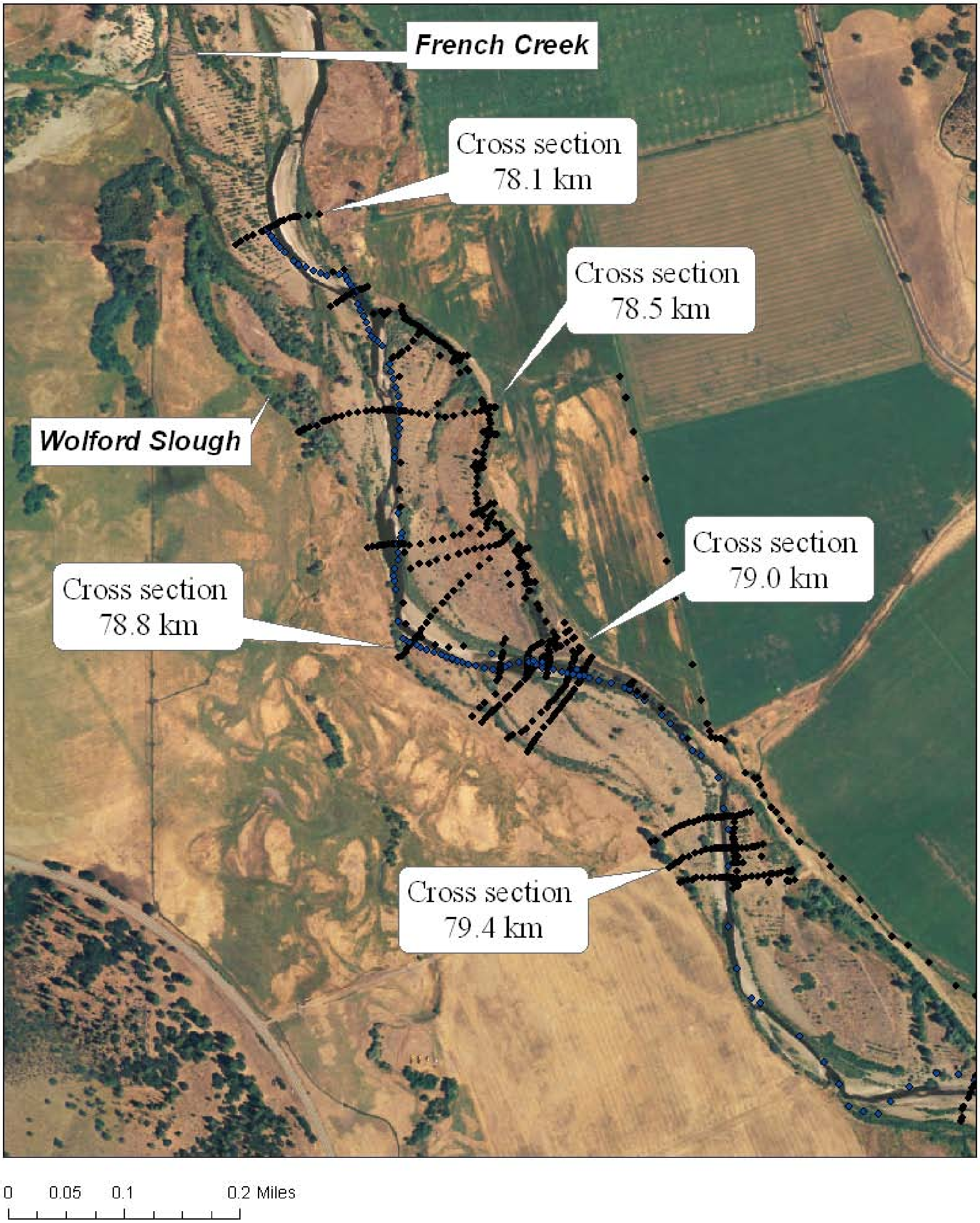
Figure 10 – Successful cottonwood planting north of the confluence of French Creek

Figure 11 – Failed riparian planting on east side of Scott River above French Cr. Confluence

Analysis of stream, bank and floodplain morphology that promotes riparian survival

A reach of the Scott River upstream of the confluence of French Creek was analyzed using multiple techniques, in order to determine what factors promote riparian vegetation recruitment. A longitudinal profile and cross section survey was performed through a reach of the Scott River (Map #6) that was planted as part of the Cantara Project. Analysis of the cross section elevations and presence or absence of riparian vegetation could demonstrate the relation between access to low flow water tables and riparian success.

Scott River above French Creek



Map #6 - Longitudinal profile and cross section survey of Scott River above French Creek

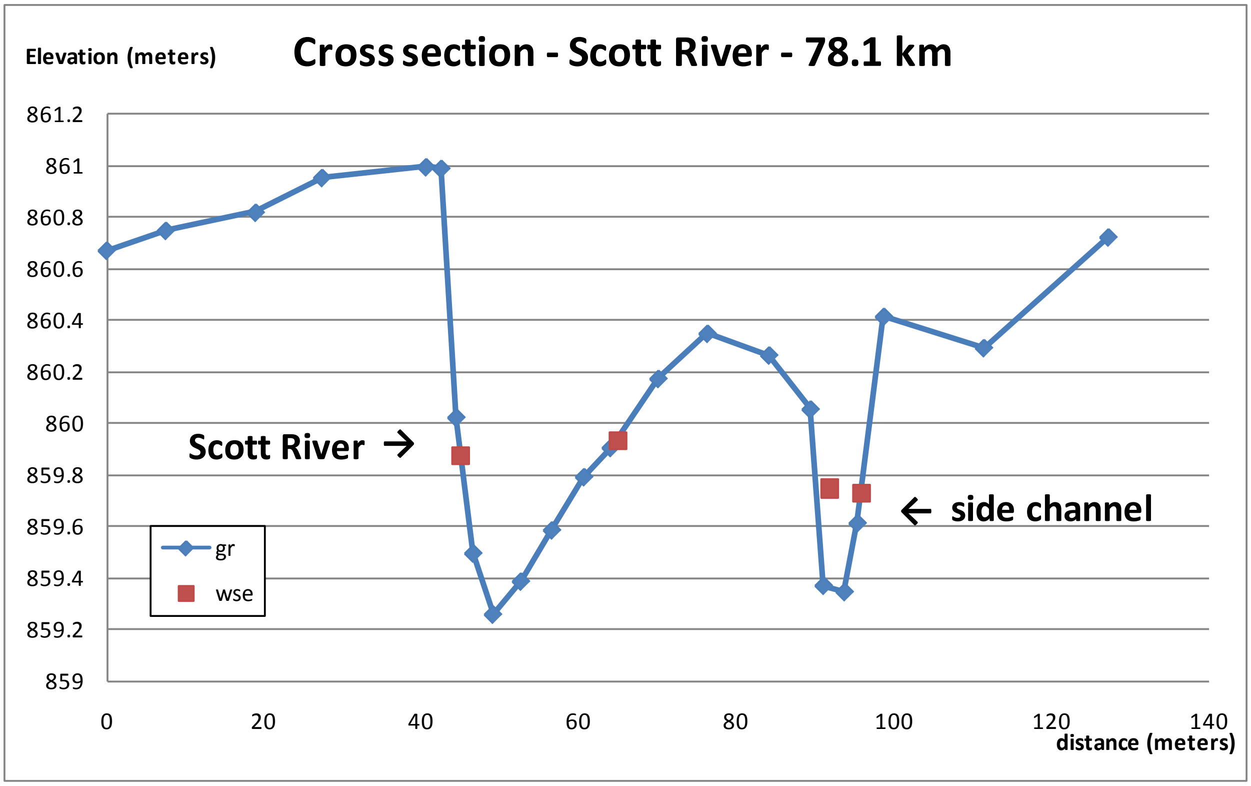


Figure 12 – Cross section of Scott River at RKM – 78.1 with water surface elevation (wse)

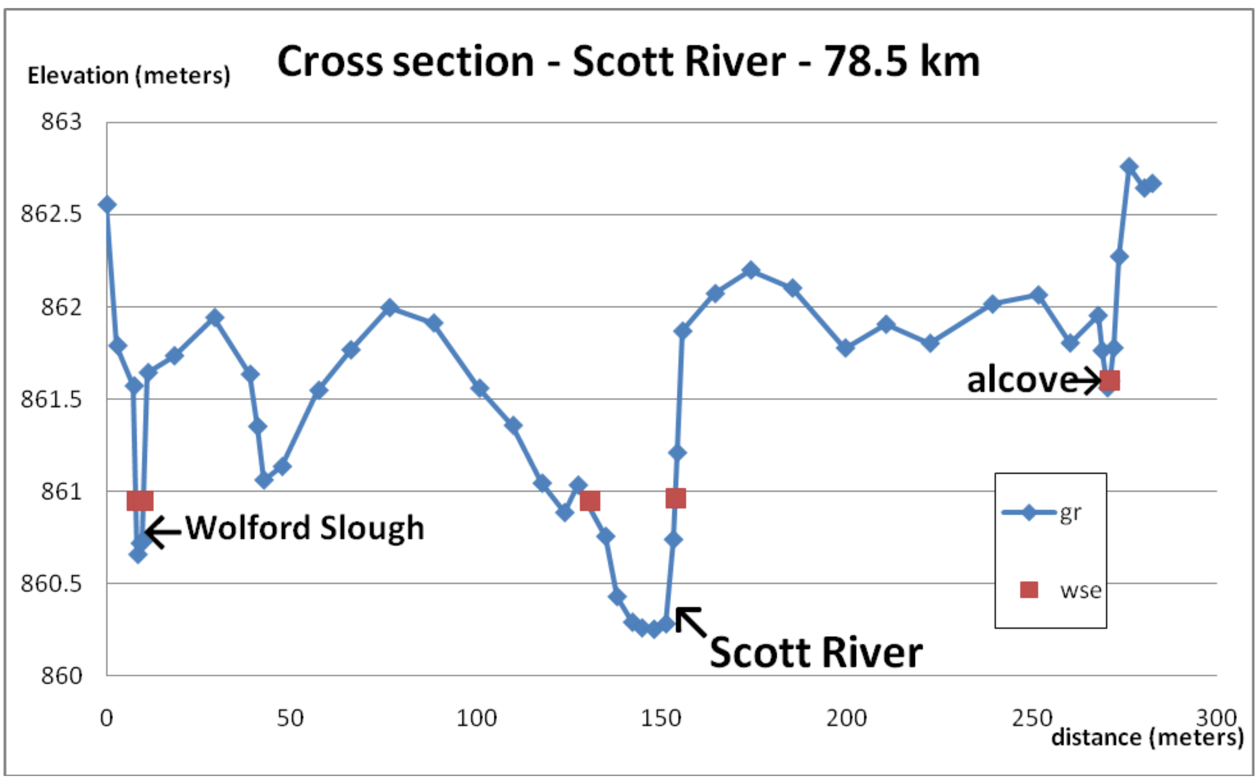


Figure 13 - Cross section of Scott River at RKM – 78.5 with water surface elevation (wse)

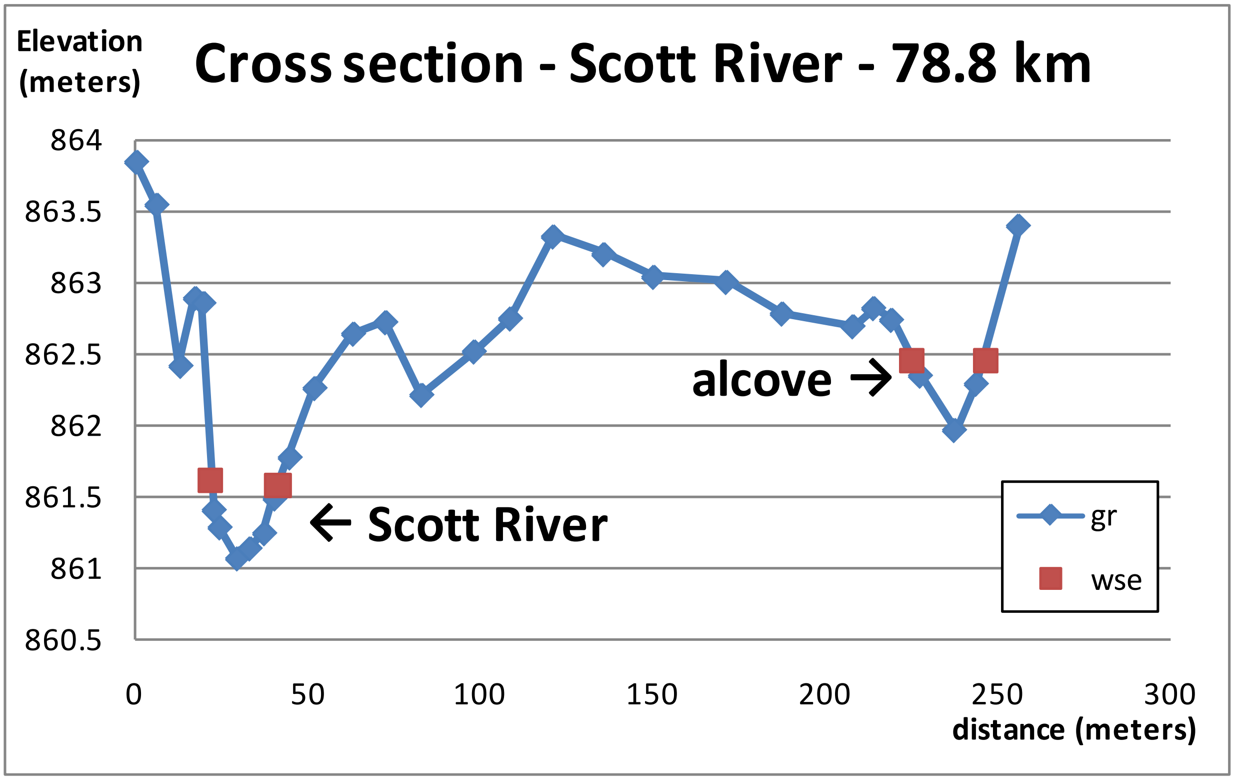


Figure 14 - Cross section of Scott River at RKM – 78.8 with water surface elevation (wse)

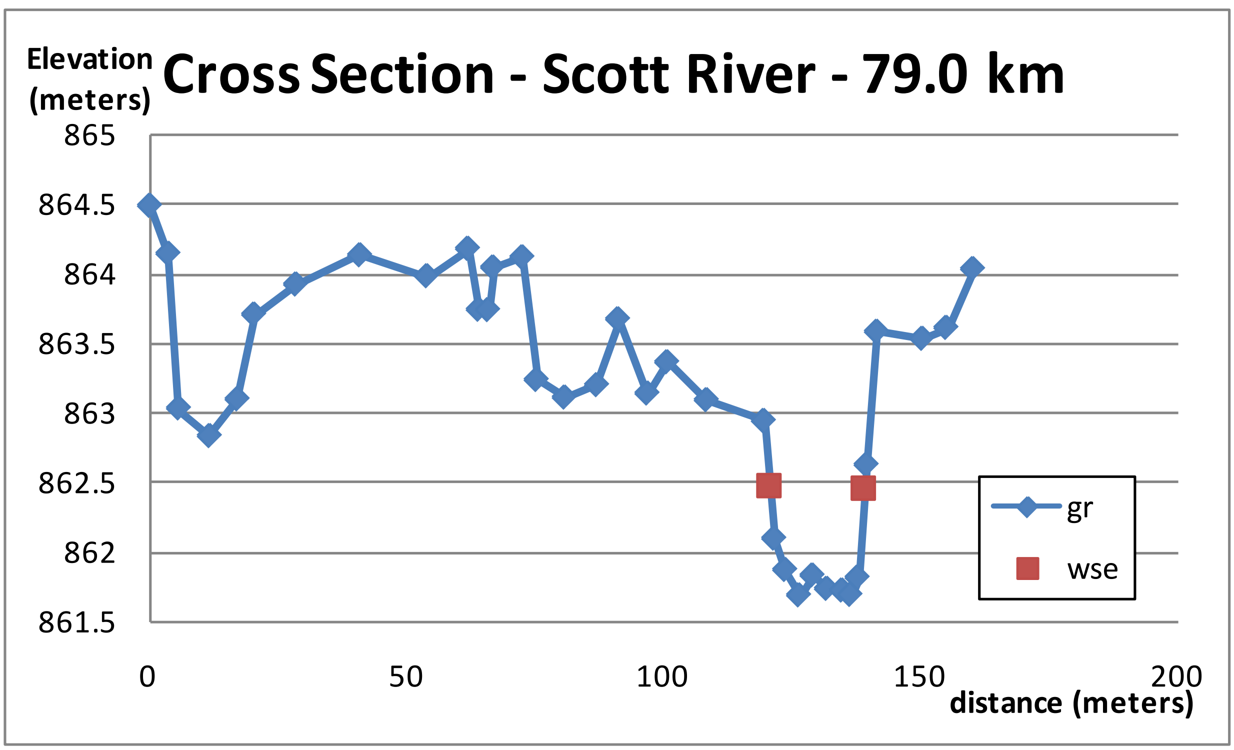


Figure 15 - Cross section of Scott River at RKM – 79.0 with water surface elevation (wse)

The downstream portion of the study reach is characterized by cross sections performed at RKM 78.1, 78.5 and 78.8 - Figures 12, 13 & 14, respectively. Wolford Slough is on the west side and a side channel (historic channel) is on the east side of the Scott River. Significant bars with maximum widths of approximately 100 meters (300 ft.) on which plantings were performed in the late 1990's separate these water features. Riparian vegetation is relatively dense along both Wolford Slough and the side channel with more limited vegetation across the bars (Figure 16). Analysis of the cross sections and water surface demonstrates that the elevations of the land adjacent to the water courses are less than those on the gravel bar. These water courses offer both surface water and land that is closer to the water table potentially increasing the survival and natural recruitment of riparian plants.

Figure 16 – Denser riparian vegetation in the background is associated with Wolford Slough

The cross section performed at RKM – 79.0 (Figure 15) shows a low elevation "trough" at the western edge (Left Bank). Analysis of the 2005 aerial photograph shows this trough is occupied by a strip of riparian vegetation in an area otherwise sparsely vegetated. Analysis of the aerial photograph captured in 1993 shows this area with lower elevation was occupied by the Scott River's channel previous to the 1997 flood (Figure 17). Though the channel has migrated, the former location has significantly lower elevation than the surrounding gravel bar creating an area with a depth to water table that is less than the depths on the adjacent gravel bar. The occurrence of riparian vegetation in this corridor with access to a "higher" water table indicates the importance of the water table's elevation in respect to the land in the success of riparian vegetation establishment.

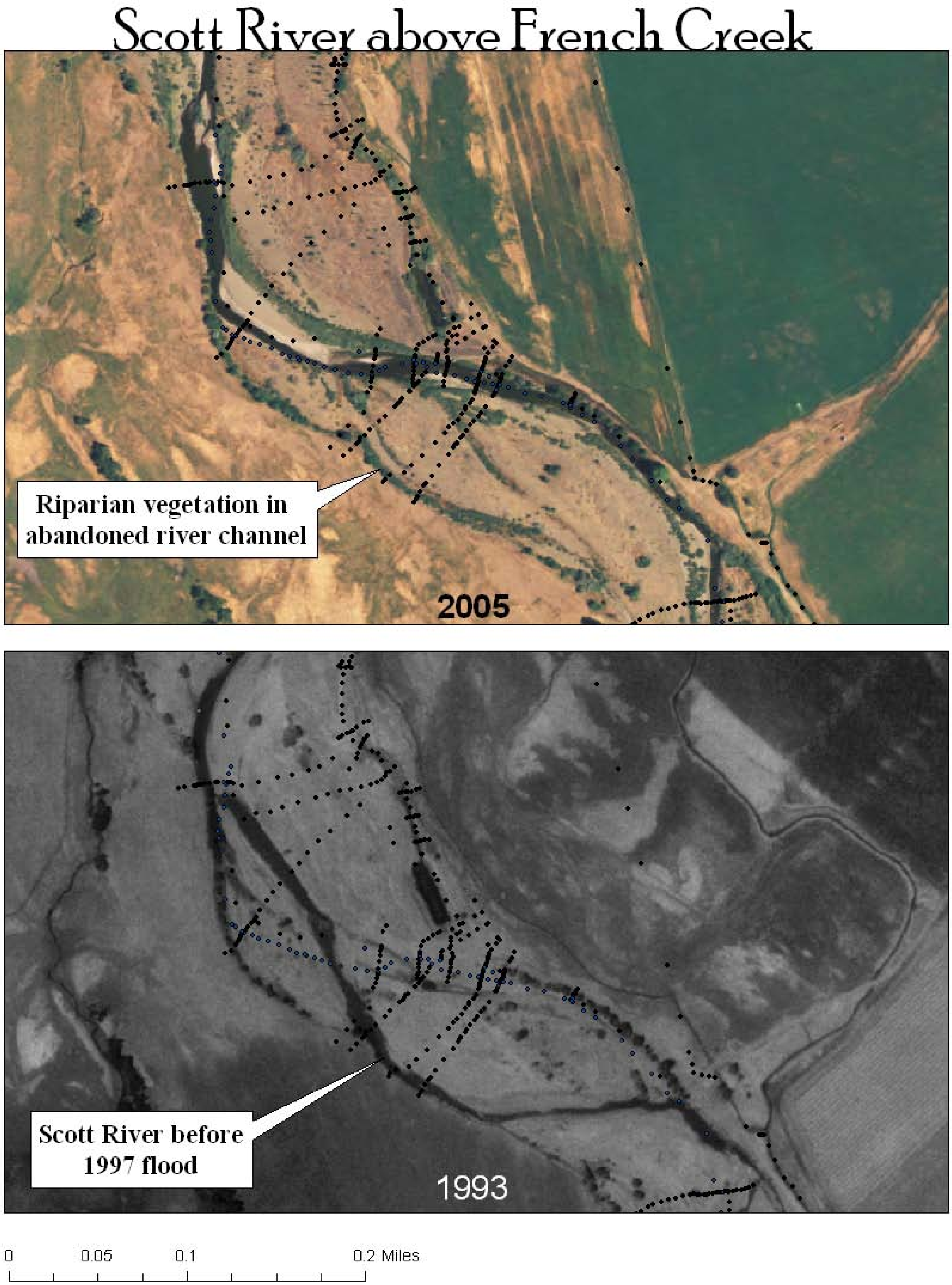


Figure 17 – Aerial images of study reach in 2005 (above) and 1993 (below)

Further analysis of the aerial images from 1993 and 2005 demonstrates multiple locations of channel alteration attributable to the 1997 flood in this reach (Figures 18a and 18b). Many of these abandoned channels are characterized by strips of riparian vegetation in the 2005 image. The reach from the bottom of the tailing pile to Youngs Dam does not have the significant elevation difference between the stream bed and adjacent lands that is observed in the leveed areas of the Scott River below Youngs Dam.

Figure 18a - Aerial image of study reach 1993

The access to the floodplain and more dynamic channel alignment in this reach has created a channel with wide gravel bars and areas of both robust and limited riparian vegetation. The elevation of these gravel bars is approximately 3 – 6 feet higher than the stream's thalweg. A potential riparian planting technique for this reach is live cuttings placed in holes and trenches excavated to the low water table elevation. Historic and natural plantings have shown that greater success occurs in areas with a shallower more stable water table and total failure can occur in areas with deeper water tables even though irrigation was installed. Placing cuttings into the water table precludes the need for the installation and maintenance of irrigation in areas with a high water table.

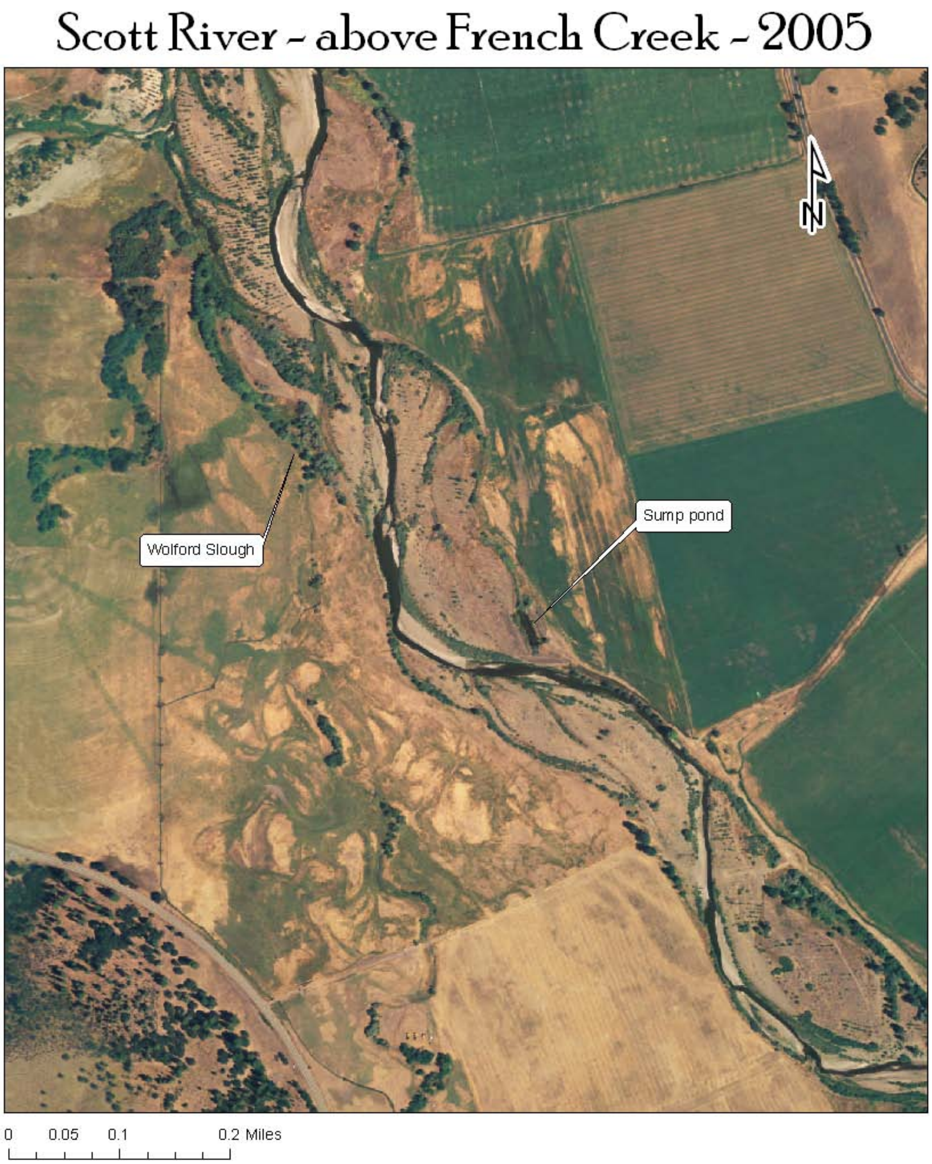


Figure 18b – aerial image of study reach 2005

<u>Scott River below Youngs Dam to Moffettt Creek</u>

Riparian plantings in this reach have not been very successful. It is hypothesized that this is partially attributable to the levees and constrained channel conditions and deeper water table. It is hypothesized that the leveed nature of the banks of this reach (downstream from Etna Creek especially) makes it not truly "riparian" This area lacks the bank structure to fully support a riparian corridor. The elevations and soil moisture of the leveed banks are characteristics more representative of the "upland zone" (Figure 19). It is expected that cottonwoods and pine trees might flourish in this but willows might have a more difficult time becoming established. The development of effective planting techniques for areas adjacent to the stream with high land elevations relative to surface and groundwater and low soil moisture is an essential prerequisite to direct future planting efforts in this reach with limited historic planting success.

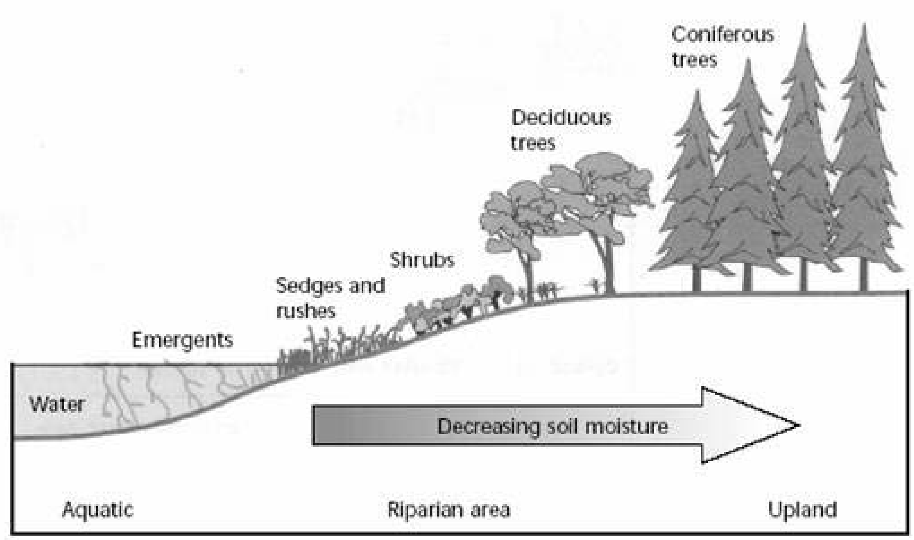


FIGURE 1 *Illustration of the moisture gradient in a typical riparian ecosystem (from Stevens et al. 1995:2).*

Figure 19 – Schematic illustration of "typical" riparian ecosystem

Figures 20 and 21 depict representative cross sections for the reach below Youngs Dam. Both of these cross sections have one bank that is very steep with the bank's top 12 to 15 ft higher than the stream's thalweg. The width of the available riparian land between fences is significantly less than the cross sections discussed for the reach upstream. Each cross section has an area of gravel bar with moderate slope on the bank opposite the steep bank. The current riparian density and distribution at RKM – 66 is mixed with areas of dense mature vegetation and areas vegetated with only grass and weeds (Figure 22). Some of the successful "riparian" plants are non-native species of trees introduced by the Soil Conservation Service – the trees on the right of this photograph are examples of these introduced trees. These trees are a mix of conifers, deciduous trees and willows. This example of successful plantings with trees that are not exclusively riparian is a potential model for future planting efforts.

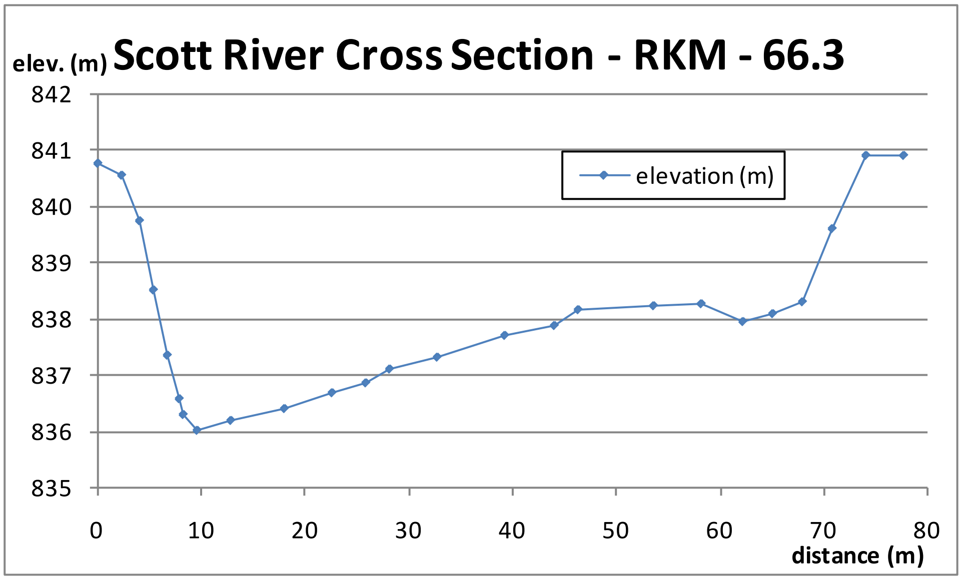


Figure 20 – Cross section at RKM – 66.3

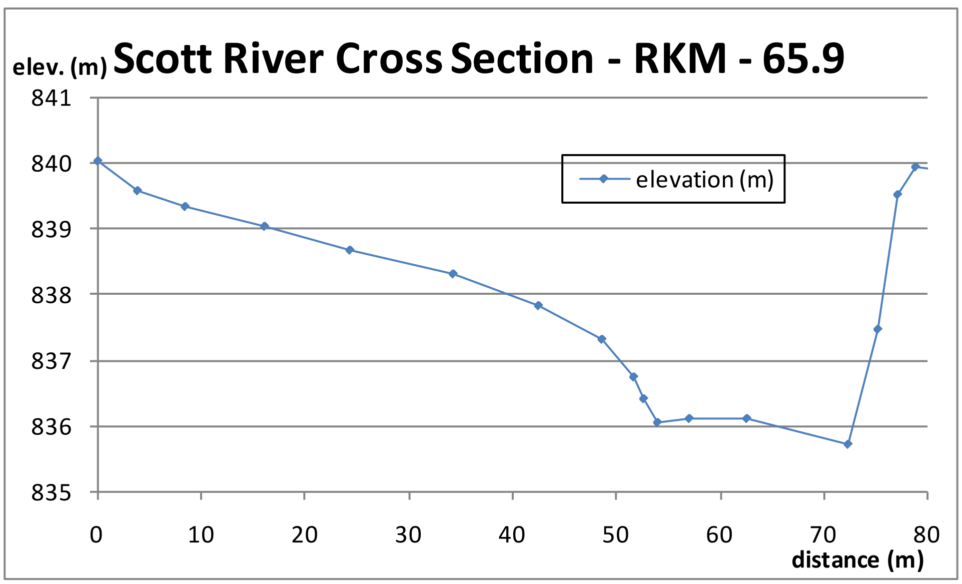


Figure 21 - Cross section at RKM – 65.9

The landowner of the surveyed reach has noted that a large number of the mature cottonwoods that were present through this reach have died in the near past. It is hypothesized that stream down cutting through this reach has lowered the water table effectively leaving the mature trees root structure above the base flow water table resulting in death. This example demonstrates the importance of insuring the survival of existing riparian vegetation while trying to introduce new riparian growth.

Figure 22 – Riparian canopy in area of RKM - 66

According to Wayne Elmore of the NRCS Riparian Service Team (Elmore 2004) "Portions of this reach of the river were channelized or leveed by the U.S. Army Corps of Engineers starting in 1938. The channelization straightened and thus shortened the length of Scott River. The shorter length causes an increase in velocity and subsequently leads to channel bed down-cutting. The down-cutting causes an overall lowering of Scott River bed elevation. The river can no longer access its historic frequent floodplain, which prevents it from dissipating energies during frequent events like 2- and 5- year events. The increased river energy has resulted in the need to rip-rap many sections of the river to prevent loss of adjacent agricultural areas. The vegetation along the channel is relatively sparse for the size of the Scott River. Agricultural areas have encroached on the banks of the river and leave little space for riparian vegetation. The root masses of existing riparian plants are insufficient to withstand the erosive forces of peak flow events. It is probable that cottonwood and willow composed a substantial portion of a much wider historic riparian zone. Few of these stabilizing trees and shrubs are present. Historically, a wide area of live trees and roots were intertwined with down, buried and partially buried LWM that combined to dissipate stream energy."

Elmore further states that "*A consequence of the channelization and levees is that the broad and relatively level floodplain no longer stores water for late-season release. As soon as the spring flow drops, the deeply incised channel cutting through the valley floor allows the accumulated groundwater to run into the relatively empty Scott River. The channel now acts as a drainage ditch similar to those used to drain wet areas. Historically, when the river bed was higher, the hydrostatic pressure of the river and its saturated bed held back the groundwater in the valley until late in the summer and early fall. Additionally, portions of the Scott Valley were historically* *home to large beaver colonies that created a maze of small dam complexes that stored large quantities of water. This water was gradually released during the late summer as adjacent river flows decreased. A greater amount of water was in the river longer when all the tributaries were at full potential for water storage. The fact that more water was infiltrated throughout the landscape, tributary floodplains, and valley floodplain, created a regime within which a longer period of time was required for groundwater molecules to wait their turn to exit the Scott River watershed*." This contributes to the observed lower groundwater table in this reach of the river.

However, some level of stream shading can be supplied in this reach. Lewis (1992) indicated that mature cottonwood could provide an almost closed canopy over this narrow stretch of the river. Plantings completed at Serpa Lane in 1992 demonstrate excellent success of riparian planting when proper irrigation is maintained. These planting are beginning to provide significant afternoon shading of the Scott River.

Many of the surveyed riparian planting sites that had few to no remaining plants were occupied with grasses. Many of these sites had rhizomatous grasses (e.g. canary reed grass) before the introduction of plants. Efforts were made to remove the grass when the sites were prepared for planting including using an excavator to dig up the sites soil and grass. It is believed that these eradication efforts were not successful and the grasses out competed the introduced plantings for the limited water supply. Development of techniques to effectively remove invasive grasses from planting sites previous to the placement of plants is an essential step to insure future planting efforts have the highest probability of success.

Scott River from Moffettt Creek downstream

The reach of the Scott River just above the canyon is not entrenched, and can access the floodplain during typical high flow events. Plantings within this reach have been fairly successful. This is likely due to a more accessible water table. There are currently no cross section surveys for this reach for comparison to the upstream reaches. Photographic evidence (Figures 23 and 24) demonstrate the gradual grade of the stream banks, an accessible flood plain and areas of good riparian density and growth. Figure 24 illustrates the presence of vegetation types that are representative of the types in the schematic diagram of typical riparian types. There is emergent vegetation (grasses) along the bank that is directly adjacent to the stream's active channel with willow shrubs in the area of slightly higher elevation. No mature deciduous is observed in the elevations above the willow shrubs in Figure 24, but mature deciduous vegetation can be seen on both sides of the Scott River above Meamber Bridge. The lack of levees in most areas of this reach allows for a wider more dynamic river with areas dominated by large mostly barren gravel bars. The downstream portion of this reach is characterized by significant amounts of accretion to surface water flows. Insuring that the cold water from the accretion flows is not instantly warmed by solar radiation is an objective of future riparian planting efforts. The downstream portion of this reach has some of the highest density of adult Chinook salmon spawning observed in the Scott River. Protecting this key spawning habitat from fine sediment pollution from stream bank failure and adjacent land use is another objective of riparian planting and protection efforts.

Figure 23- Scott River at Meamber Bridge looking upstream

Figure 24 – representative stream bank above Shackleford Creek

Successful sites: Riparian planting efforts in the Scott River below Meamber Bridge were successful when the plantings survived the initial period of establishment. Existing growth in the surveyed areas have reached heights greater than 20 ft at 8 years of age. Some locations within the planting sites show no survival but this may be due to high waters from the 2005 flood. This site has also experienced some natural recruitment. Overall survival is estimated at less than 20%. This site would likely have benefited from irrigation.

The site directly downstream from the confluence of Meamber Creek was also considered a success. The surviving trees have large amounts of growth and 85% of them are greater than 10 feet tall. This site benefited from adequate irrigation and maintenance. However, natural recruitment appears to be largely absent in the areas currently dominated by grasses.

Failed sites: The riparian planting along the Scott River directly below Moffettt Creek have mostly failed. The soil in this area is primarily composed of gravel and cobble with little fines. Currently, the site is completely barren offering no protection for plantings when summer temperatures at the site soar above 100 degrees. The drought of 2001 and 2002 stressed the newly planted trees and the high waters of 2005 deposited sand and gravel on the remaining plantings. Field observations noted that the terraces are of higher elevation than those found in the downstream portion of this reach. The elevation of the terraces is not as far above the stream elevation as the leveed area of the Scott River but it is hypothesized that this area still has some landforms adjacent to the river with low soil moisture and a significant distance to the base flow water table. This area that is downstream of the constrained and leveed portions of the Scott River could also experience greater amounts of stream channel alteration and stream bank erosion that reduces the survival of natural and introduced riparian plantings.

Chapter 5 - Priority Locations for Riparian Vegetation

Main stem Scott River

The following factors have been identified in the prioritization of planting locations for the main stem Scott River. They are listed in order of importance.

1.) Success or failure of past riparian planting efforts.

   a. Planting should be prioritized in past locations identified as successful (if needed) to expand and enhance the existing riparian corridor.

   b. The reach from Fay Lane to Etna Creek has shown moderate to good success in past planting efforts. Planting some of the areas currently lacking riparian vegetation would increase the density and distribution of riparian shade in this reach with documented accretion flows.

2.) Depth to base flow (low) water table.

   a. The morphology of the main stem Scott River and adjacent banks and floodplain should be surveyed (*e.g.*, longitudinal profiles and cross-sections) to determine the depth to water in representative locations. Plantings should focus on locations with a relatively stable and shallow water table when possible.

   b. Planting techniques for areas with a deep water table need to be developed to insure success.

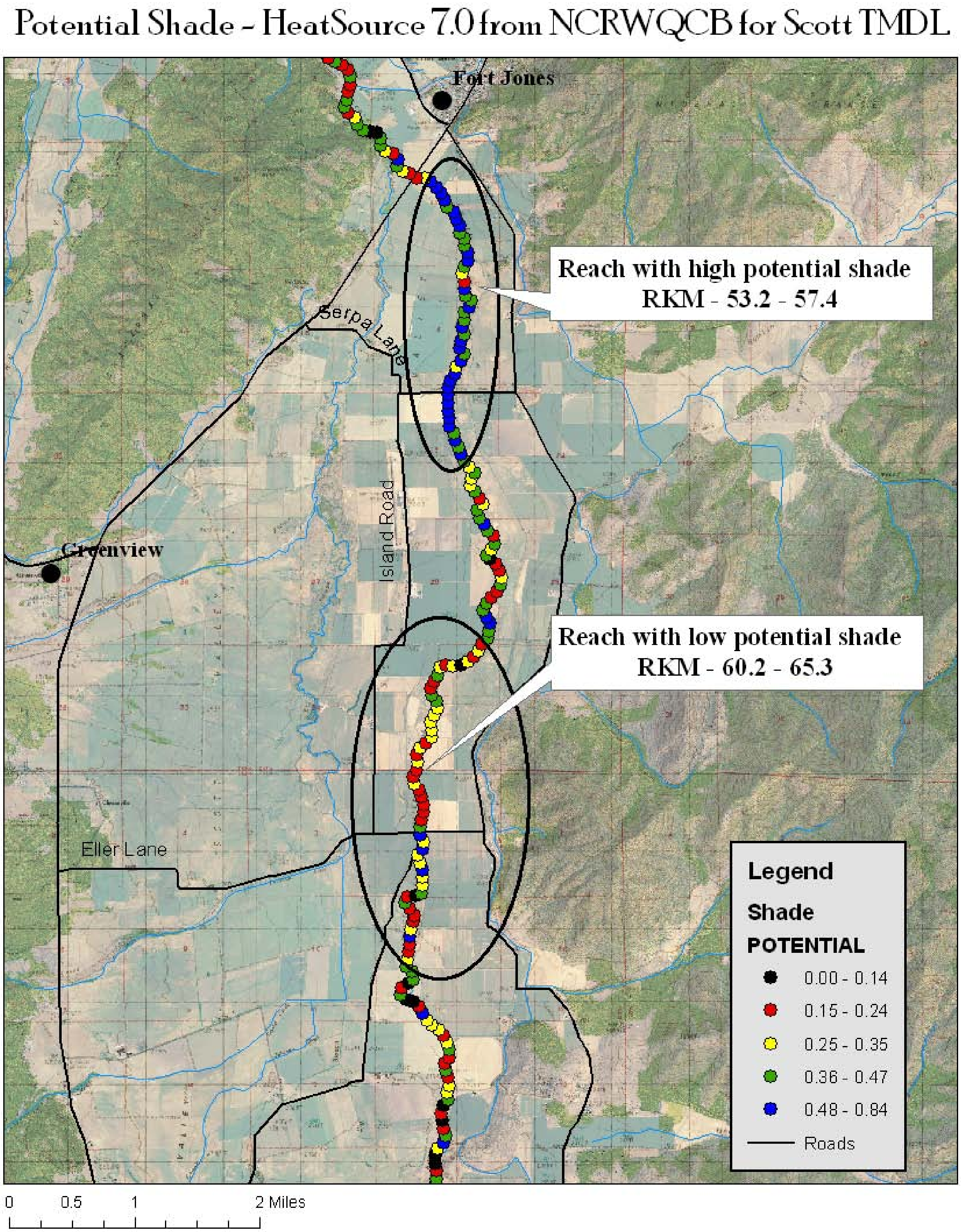
3.) Start planting efforts in the upstream portion of the stream to prevent cool surface water from heating by solar radiation.

   a. Planting efforts should initially focus on the downstream end of the tailings reach to protect the cool water exiting the tailings.

   b. Planting efforts should be focused in areas of documented surface water accretion to protect the resulting cooler water and potential thermal refugia for rearing cold water fish.

4.) Areas with the highest potential shade per HeatSource Model

   a. Plantings in areas with higher potential shade values will generate the greatest reduction of stream heating from solar loading.



Map #7 – Potential shade values calculated for 0.1 km nodes of the Scott River – data developed in HeatSource 7.0 by the NCRWQCB for the Scott River TMDL.

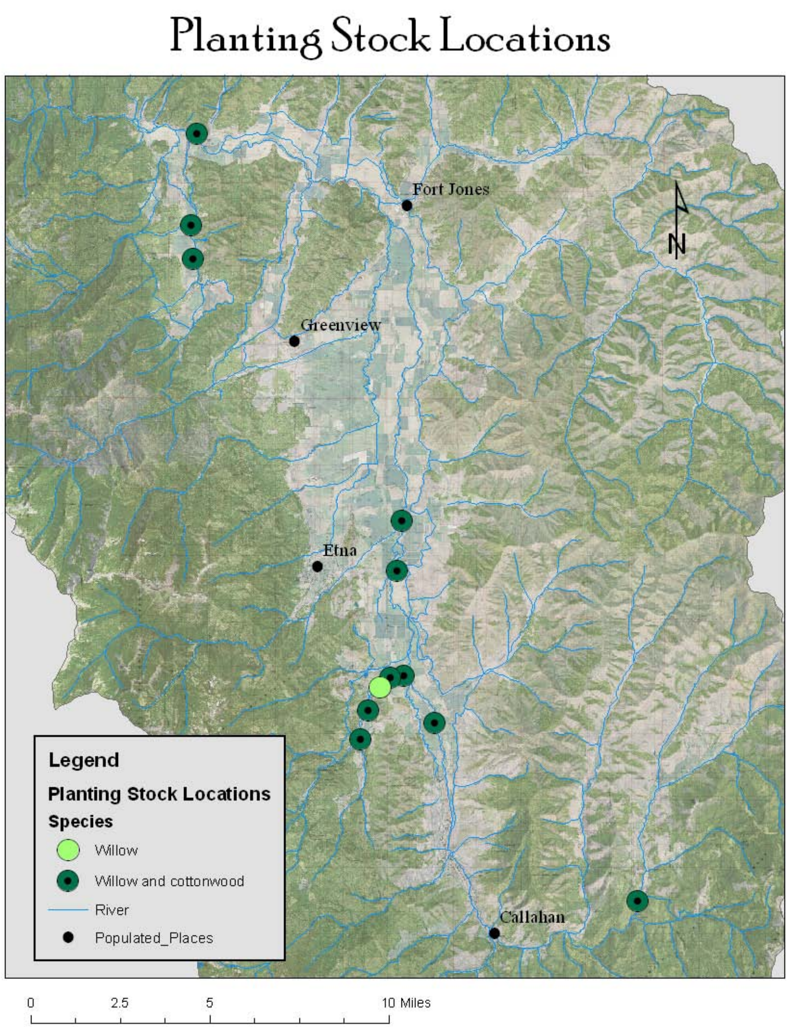
Tributary locations

The first priority for planting sites in the tributaries should focus on locations with a stable channel above the alluvial reaches.

- French Creek from Miners Creek to Hwy 3.
- Mill Creek from disconnected reach to confluence with Shackleford
- Shackleford Creek from confluence with Mill to disconnected Reach

Identified Locations with Native vegetation

Based upon observations during the inventory of previous riparian restoration projects, as well as observations from planting projects, the following locations have been identified as having sufficient existing native vegetation to serve as a source for live planting stock. See Map # 8 Native Vegetation Locations.



Map #8 – Locations with currently available planting stock

Main stem Scott River:

Location	**Location**	**Species**
Confluence of Etna Creek	T42N R9W Sec 23	willow, cottonwood
Above Horn Lane	T42N R9W Sec 26/35	willow, cottonwood
Confluence of French Creek	T41N R9W Sec11	willow, cottonwood
Above Fay Lane	T41N R9W Sec24	willow, cottonwood
Downstream from Meamber Bridge	T44N R10W Sec 26/27	Willow
Below Highway 3	T43N R09W Sec 3	Willow, cottonwood

Tributaries

Location	**Coordinates**	**Species**
Mouth of French Creek	T41N R9W Sec11	Willow/cottonwood
French Cr. Above Miners Rd Crossing	T41N R9W Sec15	Willow/cottonwood
French Creek above Hwy3	T41N R9W Sec10/15	Willows
East Fork - Lower Masterson Rd to Grouse Creek	T40N R8W Sec18	willow, cottonwood
Confluence of Miners and French Creek	T41N R9W Sec 22	Willow/cottonwood
Shackleford/Mill Confluence	T43N R10W Sec11	willow, cottonwood
Mill Creek below Quartz Valley Rd Crossing	T43N R10W Sec 14	willow, cottonwood

Chapter 6 - Recommended techniques and planting methods

Based on the analysis of previous riparian planting projects and review of professional literature, the following recommendations are made for enhancing the success of future riparian restoration efforts in the Scott Valley.

1.) Planting sites should be selected based on the prioritizations identified in Chapter Five.

2.) Perform channel cross-section surveys to identify relative depth to water table and natural swales (depressions) prior to the implementation of planting at any location.

3.) Utilize live cuttings (pole and brush) buried in holes and trenches excavated to the low flow water table in appropriate locations.

4.) All plantings on the main stem Scott River should be maintained for a minimum of three years. Maintenance of rooted stock should include: irrigation, browse and weed protection and shade cards to prevent cambium burn. Live cuttings could include (depending on site characteristics): irrigation in critical dry periods, browse and weed protection and shade cards. All planting sites should be surveyed in spring to assess any maintenance requirements (e.g., replacement of cages). At the end of the three year period each planting site should be evaluated to assess the need for future maintenance.

5.) Plantings in stable tributary locations should be protected from browse and with shade cards in barren landscapes. The need for irrigation in tributary locations should be determined on a per site basis.

6.) At sites with high potential for future bank erosion, bioengineered bank stabilization techniques should be used to prevent further bank erosion and promote riparian establishment.

7.) Local organizations (*e.g.*, Siskiyou RCD and Scott River Watershed Council) should investigate the possibility of establishing “nurseries” of native cottonwood and pine to serve as sources for future planting efforts.

Chapter 7 - Summary and Recommendation

The Scott River riparian analysis attempted to visit and assess as many sites of historic riparian planting efforts as possible. A series of recommendations for future planting efforts have been generated through the review of the methods used to plant and maintain the various sites and the success or lack thereof of the different techniques and locations. The analysis attempted to delineate areas in the Scott River watershed that had similar characteristics so that recommendations could be tailored for the different environments. The characteristics used to delineate the different riparian areas include: historic channel and floodplain alteration, depth to water table, stability of water table, stream morphology, current riparian condition and the level of success of historic planting efforts. The riparian areas of the Scott River were broken into three main stem reaches and tributary reaches. Areas with relatively high stable water tables (*e.g.*, tributaries) and access to the floodplain (*e.g.*, above Youngs Dam) have some of the best current riparian condition and highest level of riparian planting success in the watershed. Areas with a relatively low and/or unstable water table and significant channel and floodplain alteration currently have limited riparian corridors and success of historic plantings. The development of effective planting and maintenance techniques for the reaches with limited riparian corridors and historic restoration success is an essential next step in the development of a successful riparian restoration program for the Scott River Watershed.

Several observations and recommendations were made through the performance of this analysis. The most important recommendation is that proper protection and maintenance techniques are imperative for the short and long term success of riparian planting projects. The protection and maintenance measures include removal of invasive grasses, browse protection, protection from extreme heat and irrigation in areas with a low water table. The analysis observed higher rates of planting success in areas with a relatively high water table versus areas with a relatively low water table. The pursuit of further plantings in areas with a relatively high water table is recommended. Planting sites that were planted a decade ago and currently have some success with areas of barren landscape is recommended.

The next step in the development of an effective riparian restoration program for the Scott River watershed is the development of a Schedule and Strategy for Riparian Planting as recommended in the Scott River TMDL. The Schedule and Strategy will develop techniques for planting in areas with a high and low water table. The development of effective riparian restoration techniques for areas with a low water table in relation to the land elevation is a critical step in the pursuit of a riparian restoration program for the watershed.

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USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

RED ALDER
Alnus rubra Bong.
Plant Symbol = ALRU2

Contributed by: USDA NRCS National Plant Data Center

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Alternate Names
Pacific Coast alder, Oregon alder, western alder,

Uses
Ethnobotanic: Native American tribes from Alaska to Southern California have long recognized the value of red alder and put its bark layers, roots, leaves, twigs, cones, and sap to use for a variety of purposes. The inner bark was often dried, grounded into a powder and then used as a thickener in soups or mixed with cereals when making bread.

Various layers of the red alder bark yield red, red-brown, brown, orange, and yellow dyes (Moerman1998). The various colors from the bark were used to color baskets, hides, moccasins, quills, and hair. The native Americans of the Pacific Northwest extracted a red dye from the inner bark, which was used to dye fishnets. Oregon tribes used the innerbark to make a reddish-brown dye for basket decorations (Murphey 1959). Yellow dye made from red alder catkins was used to color quills.

A mixture of red alder sap and charcoal was used by the Cree and Woodland tribes for sealing seams in canoes and as a softener for bending boards for toboggans (Moerman 1998).

Wood and fiber: Red alder wood is used in the production of wooden products such as food dishes, furniture, sashes, doors, millwork, cabinets, paneling and brush handles. It is also used in fiber-based products such as tissue and writing paper.
In Washington and Oregon, it was largely used for smoking salmon. The Indians of Alaska used the hallowed trunks for canoes (Sargent 1933).

Medicinal: The North American Indians used the bark to treat many complaints such a headaches, rheumatic pains, internal injuries, and diarrhea (Moerman 1998).

The Salinan used an extract of the bark of alder trees to treat cholera, stomach cramps, and stomachaches (Heinsen 1972). The extract was made with 20 parts water to 1 part fresh or aged bark. The bark contains salicin, a chemical similar to aspirin (Uchytil 1989).

Infusions made from the bark of red alders were taken to treat anemia, colds, congestion, and to relieve pain. Bark infusions were taken as a laxative and to regulate menstruation. The Pomo boiled the bark in water to make a wash to treat skin irritations and sores (Goodrich et al. 1980). Bark poultices were applied to reduce swelling. Chewing the bark helped to heal sores and ulcers in the mouth.

Externally the sap was applied to cuts and a poultice of the bark has been applied to eczema, sores, and aches (Moerman 1998). The twigs were made into infusions that served as liniments for sprains and backaches.

Basketry: The roots of red alder were used in baskets made by the Hupa, Whilkut, Nongatl, Lassik, Wailaki, Yurok Wiyot, and Pomo tribes (Merrill 1923). Red alder roots form the brown pattern in baskets made by the Whilkut tribe of northwestern California.

Wildlife: Deer and elk eat the leaves, twigs, and buds. Red alder seeds attract many bird and small mammal species including redpolls, siskins, goldfinches, and mice. Most of the seeds remain on the tree well into the fall and winter months, providing valuable resources for seed-eating birds, insects and mammals when other foods are scarce. Beavers eat the bark and build dams and lodges with the stems. Red alder trees provide valuable nesting for birds and thermal cover for black-tailed deer and other wildlife.

Livestock: Horses, cattle, sheep and goats browse on the leaves, twigs and buds of young alder trees.

Conservation and e*rosion control*: Red alder is an excellent species for re-establishing woodlands. The trees are used in forested riparian buffers to help reduce stream bank erosion, protect water quality, and enhance aquatic environments. Plantings of red alder are effective in controlling erosion on steep slopes in disturbed areas (Uchytil 1989). These fast-growing trees help to prevent soil erosion because of their dense canopy cover and thick litter layer that forms within the first 3 to 5 years. The leaf litter is high in nitrogen content (Labadie 1978).

Wood: Red alder wood is a high quality hardwood with a fine, even textured, cherry-like grain that is important commercially in the Pacific Northwest (Labadie 1978). It is used for cabinetry and furniture making as well as a variety of other purposes including plywood, veneers, paneling, pulp, and firewood.

Other: The small cones cling to the branches long after the leaves have fallen and make decorative additions to flower arrangements (Brenzel 2001).

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
General: Birch family (Betulaceae). Red alder is a deciduous tree native to the Pacific Northwest of North America. The trees are medium-sized, reaching various heights from 15 to 30 meters tall when mature. These fast-growing trees often grow 1 meter per year until 20 years of age. The trees can live to 100 years of age with trunks from 36 to 46 cm in diameter. A shrub form occurs when the trees grow in open exposed areas. The branches are slender and spreading. The thin bark is generally smooth, ashy gray to grayish-brown, and is usually covered with white lichens as it ages. The inner bark is reddish brown.

The alternately arranged leaves are dark green, simple and broadly ovate. The leaves are 6 to 15 cm long with a pointed tip. The leaf edges are serrated or softly lobed and slightly rolled under, giving a dark-green edging effect from the underside of the leaf. The undersides of the leaves are rusty colored and covered with fine soft hairs.

The trees are monoecious, bearing both female flowers and male catkins. The tassel-like catkins grow in cluster of two to four. The catkins are greenish-yellow and 10 to 16 cm long. The flowers appear in spring either before or with the leaves. The flowers develop into small-scaled cones (fruits) that are 2 to 2.5cm long and 1 to 1.5 cm across. Each cone contains from 50 to 100 seeds that are tiny flat nutlets. The abundant seeds are wind dispersed from May to winter months.

Red alder trees invade clearings or burned-over areas and forms temporary forests (Grimm 1967). Over time, red alders build up the soil with their copious litter, and enriched it with nitrogen compounds formed by symbiotic bacteria that live in little nodules on their roots. Red alder stands are eventually succeeded by Douglas fir, western hemlock, and sitka spruce.

Environmental Affairs Office
Washington State Department of Transportation

Distribution: Red alder is most often observed in moist areas within 200 kilometers of the Pacific Coast of North America from Alaska to Southern California at elevations below 762 meters (Uchytil 1989). It also occurs along streams and lakes from the Yukon Territory and British Columbia south through the Rocky Mountain region to Colorado and New Mexico, and along Sierra Nevada to Lower California (Britton 1908). Red alder has spread to upland areas since European contact because of increased disturbance, such as logging, which opens up sites for colonization.

For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Red alder trees are often associated with mixed evergreen forests and redwood forests in coastal areas. The trees grow in riparian forests along streams, in swamps and in marshy areas.

Adaptation
Red alder has two adaptations that allow the trees to colonize bare infertile substrates: 1) the roots have nodules that house symbiotic bacteria which fix nitrogen from the air contained in the pores of the soil, and 2) the seeds need sunlight to germinate.

Actinomycetes (filamentous bacteria) in the genus *Frankia* invade alders through their root hairs and stimulate cell division, forming nodules on the roots (Pojar & Mackinnon 1994). Species of *Frankia* remove nitrogen from the air and 'fix' it in a form useful to plants (Ibid.). Red alder provides a home for the actinomycete, which in turn 'leaks' some of the nitrogen, making it available for the alder (Ibid.). Alder improves soils fertility by fixing atmospheric nitrogen in a form that can be used by other plants. This conversion is why forests stands containing alder generally have a rich understory (Ibid.).

Young trees can survive disturbance by resprouting from the stumps (Labdie 1978). Red alder trees tolerate flooding and can grow in areas where the water is brackish (Brenzel 2001).

Establishment
Red alder prefers moist, well-drained, deep sandy loams (Labadie 1978) and full sun. Quick growing red alders can be planted with slower growing trees such as oak to provide quick screening (Lowry 1999).

Propagation from Seed: Red alder trees are generally propagated from seed. Mature seeds can be collected beginning in May. Spring sown seeds of *Alnus rubra* should germinate successfully as long as they are not covered as the seeds require sunlight to germinate and germinate best in full sun. Sow the seeds in containers or seed trays containing a slow release fertilizer. Firm the medium and place the seeds thinly and evenly on top. When large enough to handle, the seedlings can be placed into individual pots. If growth is sufficient, they may be planted into their permanent positions in the summer, if not they can be planted the following spring.

The seeds do not require pretreatment, however germination can be improved by cold stratification for 1 to 3 months (Emery 1988). To do this, mix the seeds with three parts moistened peat moss or vermiculite. Place the mixture into an airtight jar or sealed plastic bag in the refrigerator for 1 to 3 months before planting. This process is not necessary if the seeds are planted in the fall, as the temperatures and moisture over winter will accomplish the same purpose.

Management
If desired, red alder trees can be pruned for shape when young (Labadie 1978). Follow up pruning is minimal and consists of removing any suckers that may form as well as removing dead wood or crossing branches.

Pests and Potential Problems
Aphids and tent caterpillars and borers can be problems for red alder trees.

Related Species
White alder (*Alnus rhombifolia*) was also widely used for the same purposes as red alder by Native American tribes. White alder occurs in inland areas while red alder generally grows in areas of maritime influence. Red alder and white alder can be difficult to distinguish from each other. White alder does not have red inner bark or rolled leaf margins.

Cultivars, Improved and Selected Materials (and area of origin)
These plants are readily available through native plant nurseries.

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Plant Guide

PACIFIC WILLOW
Salix lucida Muhl. ssp. *lasiandra* (Benth.) E. Murr.
Plant Symbol = SALUL

Contributed by: USDA NRCS National Plant Data Center

Charles Webber

Alternative Names
yellow willow, red willow, black willow, whiplash willow, golden willow, caudate willow, western black willow, waxy willow, western shining willow, *Salix lasiandra* (SALA5)

Uses
Ethnobotanic: The inner bark was dried, ground into a powder, and then added to flour for making bread. The stems and bark were used in basket making (Moerman 1998). The native Americans used the stems for bow making and the bark for fabric making and tea.

Medicinal: Willows produce salicin, which is closely related to acetylsalicyclic acid, commonly known as aspirin. Various preparations from willows are used to treat stomachache, sore throats, colds, diarrhea, and dandruff. The inner bark is haemostatic and has been applied externally to bleeding cuts (Moerman 1998).

Landscaping & Wildlife: Pacific willow is an excellent species for use in landscaping. It provides food and cover for many wildlife species. Deer and elk browse the young shoots of the plant. It is also a preferred food of mouse and cattle.

Agroforestry: *Salix lasiandra* is used in tree strips for windbreaks. They are planted and managed to protect livestock, enhance production, and control soil erosion. Windbreaks can help communities with harsh winter conditions better handle the impact of winter storms and reduce home heating costs during the winter months.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Pacific willow (*Salix lasiandra*) is a tall, slender, large shrub or small tree, fifteen to forty-five feet high (McMinn & Maino 1963). The leaves are long, thin, shiny, five to ten centimeters long with finely
toothed edges. The fruits are thick catkins that are hairless, light reddish-brown, and six to eight millimeters long. The bark is furrowed with broad flat scaly plates.

Distribution: Pacific willow is native along stream banks from British Columbia southward to southern California and New Mexico (McMinn & Maino 1963). For current distribution, please consult the Plant profile page for this species on the PLANTS Web site.

Adaptation
Salix lasiandra is a fast growing but short-lived tree. This species prefers a damp heavy soil but will succeed in most soils. This species is often found in riverbanks, floodplains, lakeshores, and wet meadows often standing in quiet river backwaters (MacKinnon, Pojar, & Coupe' 1992). It grows best in a sunny position scattered at low elevations along major rivers (Ibid.).

Establishment
Propagation from Seed: Seeds must be sown as soon as they are ripe in the spring. Seeds are viable for only a few days and the maximum storage period is four to six weeks with germination rates dropping off fast after ten days at room temperature (Dirr & Heuser 1987). Willow seeds have no dormancy and germinate within twelve to twenty-four hours after

falling on moist ground (Ibid.). Seedbeds must be kept moist until seedlings are well established.

Propagation from Cuttings: Hardwood cuttings can be collected and prepared for insertion, normally from November through March. Cuttings seven to ten inches long and a half to one inch thick are initially stuck close and dug after one year (Dirr & Heuser 1987). Willows have a rooting percentage of ninety to one-hundred percent and the rooting number is not promoted by rooting hormones (Ibid.).

Management

Pacific willow is used to colonize disturbed sites for streambank stabilization projects. Cuttings are used for revegetating disturbed riparian areas to extract soil moisture and high amounts of carbohydrates.

Cultivars, Improved and Selected Materials (and area of origin)

Available from wetland plant nurseries within its range. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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FORESTRY TECHNICAL NOTE

Improving the Establishment of Willow Cuttings in Riparian Areas

Robert Logar, State Staff Forester
Joseph Scianna, Horticulturist

Introduction: Many riparian areas can be improved by supplemental plantings that enhance stream bank stability, increase biodiversity, create wildlife habitat, and improve water quality. One method of supplemental planting is using willow cuttings along the stream bank. Adventitious rooting of willows is easy and successful when performed properly. This Technical Note describes important establishment factors and techniques when using willow cuttings in riparian plantings.

I. TECHNIQUES:

A. Planning: Determine if willows are indigenous to the site you intend to plant. Determine if the site has the hydrology, soils, frequency, and duration of flooding needed to support adventitious rooting of willows, as well as successful long-term establishment and growth of plants. Proper riparian grazing management must be in place to allow establishment and growth of cuttings. Notify the appropriate agencies and obtain any needed permits prior to starting any reshaping work.

Note: Several management factors have been determined to be critical in Montana for successful plant establishment in riparian conservation practices. Livestock exclusion until woody plants are adequately sized to tolerate browsing, trampling, and rubbing is necessary prior to riparian project initiation. Physical or electrical exclusion with fencing is necessary. Protection from wildlife including deer, moose, rabbits, mice, voles, and other rodents is also necessary. Use tree shelters, repellants, sacrifice crops, and other animal control techniques to exclude or minimize damage to woody plantings in riparian projects. Drift from non-selective and broad-leaf selective herbicides, especially when applied to adjacent pasture and rangeland from aircraft or large ground sprayers, can be detrimental to woody plant survival, establishment, and growth. Herbicides with lengthy residual soil activity may prevent adventitious root formation or survival of transplanted nursery stock. Examine past and planned herbicide prescriptions and applications for the riparian area and adjacent land prior to project initiation. Make sure that herbicides are labeled for use near riparian areas (surface water) and are compatible with woody plants.

B. Species Selection: There are numerous willow species with varying growth habits native to Montana. Select willow species and types appropriate for the planting site. Inventory the proposed planting site, or a comparable site within close proximity, for existing woody species and growing conditions (Riparian Planting Zone, elevation, etc.). On-site observation is the best method to assist in the species selection process. When possible, plant the same species and/or type of willow in stream locations and Riparian Planting Zones in which they are normally found. Success will significantly increase when these steps are followed. Select species with a high probability of producing adventitious roots. Reference Plant Materials Technical Note No. MT-36, *Users Guide to the Description, Propagation and Establishment of Native Shrubs and Trees For Riparian Areas in the Intermountain West* and *Plants for Riparian Buffers*, USDA-NRCS Plant Materials Centers, Idaho and Montana, for species root-ability.

C. Source of Cuttings: Willow cuttings may be procured from commercial nurseries as un-rooted or rooted cuttings, or they can be obtained from native stands located near the site. When using cuttings from commercial sources, select species and stock sources compatible with the planting site. If commercial cuttings taken from local donor plants are not available, use cuttings taken from parent plants found growing under similar environmental conditions, especially in relation to elevation and USDA Winter Hardiness Zone. When local stands of appropriate species are available, collect from native stands of healthy trees in closest proximity to the planting site. Do not over harvest cuttings from native stands. Commercial cuttings generally have better vigor, are more uniform and establish more successfully than native cuttings.

D. Cutting Diameter: Inadequate cutting diameter has been identified as a contributing factor to poor adventitious root formation from cuttings. Use or harvest cuttings that are ½ to 1 inch in diameter (at least index finger diameter). Take cuttings from wood that is 3 years old or less. Wood older than 3 years has decreased adventitious rooting ability caused by decreasing pre-formed initials, decreasing adventitious buds, and increasing bark thickness. Avoid small diameter, weak cuttings with low levels of stored carbohydrates needed for adventitious root initiation and growth.

E. Cutting Length: The optimum length of willow cutting is determined by the depth to summer water table. The cuttings must extend several inches into the summer water table, three to four buds are needed above the ground, with no less than ½ the total length of the cutting remaining in the ground. It is better to have excessively long rather than short cuttings. Short cuttings sometimes results in desiccation of the cutting before root initiation and establishment. Cuttings must be a minimum of 18 inches in length.

F. Harvesting Wildland Cuttings: Select wildland cuttings from healthy, disease- and insect-free donor plants. Avoid donor plants exhibiting any signs of stress or poor growth. Cuttings are taken from dormant willows in late fall or early spring before the buds start to break. A very shallow cut below the outer bark should reveal green cambium indicating live tissue. Avoid stems with a discolored, wrinkled, or shrunken appearance. Lopping or pruning shears or a small saw can be used to harvest cuttings. Avoid harvesting suckers: they typically lack the carbohydrate reserves necessary to produce adventitious roots once planted. Select branches that will not impair donor plant health and appearance once removed. Remove the terminal ends of the cuttings down to a diameter and length as previously described. Remove all lateral side branches from the cuttings.

Note: A major challenge of using wildland cuttings is the coordination of timing of removal from the donor plant with optimum planting time. Cuttings root best if planted when fully dormant. Warm periods in late winter may result in early bud break, increased cutting stress during transport and storage, and ultimately reduced rooting.

G. Sealing Cuttings: Sealing the terminal (top), cut ends of cuttings helps reduce moisture loss from the cuttings. To identify the top of the cutting, find and examine lateral vegetative buds on the stem. The buds are usually above the leaf scar and point upward toward the end or tip of the branch. Dip the top 2 to 3 inches of each cutting into a 50:50 mix of white latex paint and water or paraffin wax to prevent moisture loss from the cutting.

H. Transport of Cuttings: Whether transporting cuttings to a storage facility or the planting site for installation, keep cuttings as humid (not wet) and cool as possible above freezing. During transport store cuttings in a trash bag or wrapped in light-colored, opaque plastic. Add small amounts of water to the storage sacks to prevent desiccation. Keep cuttings out of direct sunlight or in other locations where they are likely to heat up. Avoid transporting cuttings in an open pickup or trailer if heat build-up or wind desiccation is likely. Minimize transport time when possible.

I. Cutting Storage: Store in a cool, dark, humid environment at 32° to 38°F. Properly held cuttings will store well for up to 6 months. Cuttings store best under controlled environmental conditions including high relative humidity and cool air temperature. Inspect the cuttings frequently to determine condition.

J. Pre-plant Treatment of Cuttings: Soak the bottom half of the cuttings in water for 1 to 2 days prior to planting. Soaking initiates the growth process within the inner bark in willows. Cuttings should not be treated with rooting hormone, fungicide, or fertilizer.

Pre-Plant Tip: Pruning tools and saws used for removing cuttings from donor plants often crush basal tissues and reduce water uptake (See Figure A). In addition, cuttings tend to desiccate and die back some distance from the base during storage. To remove dead or damaged basal tissue, and to increase the surface area of the base of the cutting, use a very sharp grafting or cutting knife to re-cut the base of the cutting at an angle prior to insertion in the soil (See Figure B).

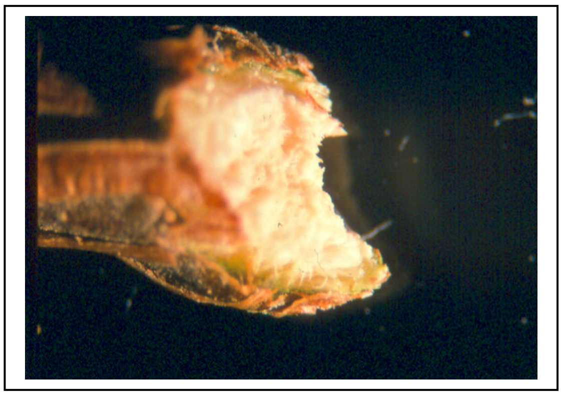

FIGURE A

FIGURE B

K. Planting Cuttings: Plant cuttings with a shovel, rock bar, hand dibble or by merely pushing the cutting into moist soil. Maintain good soil to cutting contact by eliminating all air pockets around cutting. Eliminate air pockets by firming very moist soil around the cutting with your foot, or by adding water until the soil is saturated and slumps around the cutting. Plant cuttings deep enough so that several inches of the cutting extends into the summer water table. It is critical that un-rooted cuttings have nearly constant contact with saturated soil at the base of the cutting to meet early moisture demands until roots are developed. Un-rooted cuttings require adequate soil temperature (at least 50°F) and free water to stimulate and support adventitious rooting. Un-rooted cuttings inserted in soil too early may rot or decline in vigor before soil temperatures are adequate for root initiation. Fully dormant, properly stored cuttings allow planting flexibility and contribute to increased rooting percentage.

L. Cutting Spacing: Place shrub cuttings about 1 to 3 feet apart and tree cuttings about 6 to 12 feet apart.

M. Placement: Place cuttings at toe of slope where cutting will be in saturated soil during low water.

N. Planting Maintenance and Management: Replant dead cuttings the second and third years after installation. Monitor the site and remove any dead organic material covering cuttings. After 2 to 3 years, trim willows to stimulate smaller, denser shoot growth. Inspect plantings frequently for signs of animal damage and adjust protection accordingly. Control established herbaceous vegetation around new planting.

Where to Get Help

For more information, contact your local USDA Service Center, or Natural Resources Conservation Service or Soil and Water Conservation District office.

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Vegetated Waterways and Riparian Restoration: Oakdale Ranch

By Juliet Christian-Smith

Introduction

The Capay Valley is a narrow alluvial valley located in northwestern Yolo County, California. It drains approximately 1,300 square miles of Lake, Yolo, and Colusa Counties, trending in a southeast direction from the Northern California Interior Coast Range to the Sacramento Valley. The primary landscapes are mountainous blue oak woodlands, chaparral, rangeland, and fertile valley floor agriculture (orchards and row crops). Several small rural communities are dispersed along State Highway 16, which runs the length of the Valley. The area has a primarily agriculture-based economy that includes a rapidly-growing organic farming sector (Yolo County RCD and Cache Creek Watershed Stakeholders Group 2003).

In 2003, the Yolo County Resource and Conservation District (RCD) and a group of local stakeholders released the Capay Valley Water Stewardship Plan, an effort to “deal comprehensively and thoughtfully with resource issues in Capay Valley” (Yolo County RCD and Cache Creek Watershed Stakeholders Group 2003). The report identified several major resource concerns, such as stream bank erosion, and goals and objectives to address them. Goal 1 was to manage watershed lands to minimize unnatural rates of erosion and sedimentation. Recommended voluntary actions to achieve this goal included:

- Establishing riparian buffers between stream channels and adjacent land use,
- Vegetating stream banks with native vegetation to maintain bank stability,
- Removing and/or controlling non-native invasive vegetation in the stream channel and riparian areas,
- Establishing vegetated filter strips at the tail end of irrigated crop land and orchards,
- Establishing riparian strips using native vegetation between agricultural land and streams, and
- Vegetating irrigation ditches and canals with native perennial grasses.

The vast majority of land in Yolo County is privately owned and therefore much of this work would have to be undertaken by individual landowners, at their own expense. Around the same time, Audubon California was developing its Landowner Stewardship Program to work with private landowners on resource management projects. This case study describes how the Landowner Stewardship Program collaborated with one landowner in Yolo County to restore the riparian area around Willow Slough.

Background

Vegetated waterways are intended to slow and filter the flow of runoff water, allowing suspended sediment to settle out and enabling runoff water and soluble pollutants to infiltrate the ground. The plants, decomposing vegetation, and associated microorganisms help trap sediments and take up dissolved nutrients and other chemicals. Vegetated drainage ditches have proven successful in the Midwest, reducing sediment and pesticide concentrations in agricultural drainage, especially water soluble pesticides (Bennett et al. 2005). Studies have documented that: "riparian VBS [vegetated buffer strips] can significantly reduce the concentrations of nitrate-N in shallow groundwater before its entry into a stream channel. The evidence also suggests that riparian forests are more efficient at removing nitrate-N in shallow subsurface water than are grass VBS" (Osborne and Kovacic 1993). According to the Solano and Yolo County RCDs, an appropriately designed vegetated drainage ditch can remove 38% – 98% of pesticides in and filter strips can remove 50% – 80% of pesticides and nutrients (Solano and Yolo County Resource Conservation Districts 2006a and 2006b).

Vegetated drainage ditches are typical agricultural drainage ditches planted with a selection of plants, which act as binding sites for pesticides and fertilizers that have run off fields during irrigation or storm events, reducing movement of agricultural chemicals from the field to the waterway. At sites with high concentrations of sediment in runoff water, it may be necessary to couple vegetated ditches with an upstream sediment trap to reduce sediment deposition that can smother the vegetation to prolong the useful life of the ditch (Figure 1).

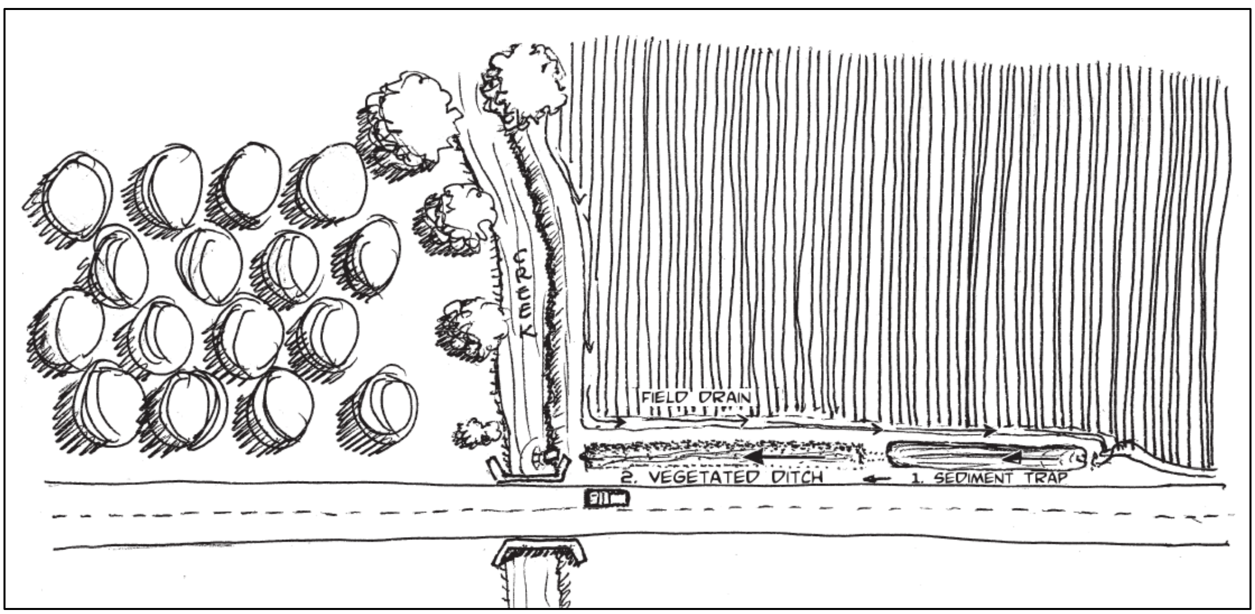

Figure 1. A sediment trap and vegetated drainage ditch slow and filter water as it runs off an agricultural field to a nearby creek
Source: Solano and Yolo County Resource Conservation Districts 2006a

Vegetated drainage ditches are eligible for Natural Resources Conservation Service (NRCS) funding through their Environmental Quality Incentive Program (EQIP). The EQIP specifications require the ditch to be constructed with sufficient capacity (width, length, depth, and grade) to discharge expected irrigation flows and surface water runoff from a 10-year event. The shape of the ditch must conform to either a U-shape or V-shape design. The ditch could contain a specified number of water control structures (such as flash board risers) to allow sufficient time for residues from application of pesticides and/or fertilizers to be utilized or adhere to ditch vegetation and reach their expected half-life before discharge into surface water bodies (NRCS 2008). More information is available from NRCS about the practice specifications (NRCS 2008).

Filter strips are areas of grass and other perennial (non-woody) vegetation that are established between agricultural fields and waterbodies. Filter strips can be established adjacent to drainage ditches, streams, lakes, ponds, seeps or other wetland habitats and have the potential to provide many benefits to onsite and offsite aquatic habitats (Figure 2). These improvements may include improved water quality, reduced soil erosion, stabilized stream banks, improved floodplain function, and recharge of groundwater aquifers (NRCS 2001). Properly designed and maintained filter strips potentially provide habitat for feeding, nesting, and resting wildlife. They also may serve as important travel corridors that allow animals to move safely between habitats. Filter strips are usually at least 12 feet wide but NRCS recommends a width of at least 36 feet if the filter strip is intended to be used as a habitat corridor, or at least 40 feet if it is intended for nesting and escape cover (NRCS 2001). In terms of water quality, wider strips provide more filtering benefits and filter strips work best if runoff flows across the strip as shallow sheet flow, rather than as concentrated flow (Solano and Yolo County Resource Conservation Districts 2006b).

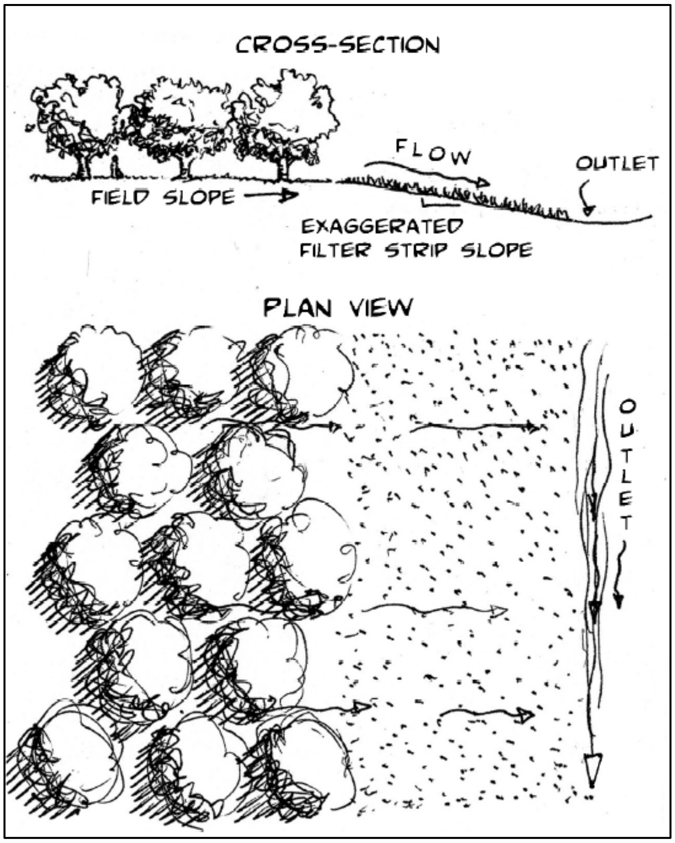

Figure 2. Cross-sectional and plan view of a vegetated filter strip

Source: Solano and Yolo County Resource Conservation Districts 2006b

In the mid-west, where filter strips are most commonly used, experience with filter strips has shown that their effectiveness is related to several factors, including:

- The amount of sediment running into the filter strip (influenced by tillage, rain, steepness of surrounding terrain),
- The amount of water that is retained in the filter strip (influenced by the width of the strip and the type of and condition of the vegetation planted),
- The infiltration rate of the soil, and
- The uniformity of water flow through the filter strip (Iowa State University Extension 2000).

In the flat fields of California's Central Valley, the design of filter strips is still under experimentation. Gentle slopes may have to be created. One possible design is an asymmetrical "V" ditch at the field end, with a flatter slope being the 12–20 foot wide filter strip and a steep slope completing the "V" (Solano and Yolo County Resource Conservation Districts 2006b).

In summary, there are many benefits related to vegetated waterways, including:

- Preventing soil erosion and stabilizing field border soils,
- Competing with and protecting against invasion by weeds,
- Improving water quality,
- Enhancing habitat for wildlife and beneficial insects,
- Providing forage hay or bedding mulch, and
- Replacing an otherwise weedy maintenance problem with a non-weedy filter strip or vegetated ditch for farm run-off (Solano and Yolo County Resource Conservation Districts 2006a and 2006b).

However, vegetated waterways also require on-going maintenance, including:

- Mowing and harvesting,
- Controlling weeds,
- Supplemental seeding every 2 – 5 years and reseeding disturbed areas,
- Removing debris, repairing gullies, and removing sediment deposits,
- Periodically re-grading and re-establishing vegetation when sediment deposition jeopardizes its function, and
- Limiting the length of time a drainage ditch holds standing water for mosquito control (Solano and Yolo County Resource Conservation Districts 2006a and 2006b).

There are installation and maintenance costs associated with vegetated waterways. The cost for installation of a vegetated drainage ditch is estimated to be around $1000 per acre or more. Costs will vary for each project, depending on the length of the ditch, the amount and type of seed used, the amount of excavation needed, and any irrigation required (Solano and Yolo County Resource Conservation Districts 2006a). The cost of a vegetated filter strip is determined by the price of perennial grass seed and any grading necessary due to field end topography. In 2006, average costs of installing a filter strip were around $750 per acre, depending on seed choice and seeding rate (Solano and Yolo County Resource Conservation Districts 2006b). Yet, according to

Rachel Long, a UC Extension scientist and Yolo County farmer, maintenance costs can higher for regular drainage ditches and weedy edges, costing around $100 per year, while a hedgerow or filter strip costs around $40 per year to maintain.

Restoring Willow Slough on the Historic Oakdale Ranch

Audubon California's Landowner Stewardship Program works with private landowners to conserve and restore wildlife habitat on working farms and ranches. The program's long-term programmatic goals are to enhance and restore riparian, oak woodland and grassland habitats, improve forage quality, improve water quality, and reduce erosion. This is a particularly valuable program in places with limited public lands, such as Yolo County, which is 90% privately owned. Responsibility for protecting public resources typically falls on individual landowners, many of whom struggle to earn all or part of their living from agriculture and lack the time, money or technical expertise to restore and maintain wildlife habitat and natural resources (EDF 2005). The Landowner Stewardship Program, together with its extensive network of partners, helps provide funding, labor and technical assistance. At the same time, landowners can shape projects to meet their own goals and keep their land in production. Over the last ten years, the program has partnered with 75 farmers in Yolo, Solano, Colusa, and San Joaquin Counties, including a slough restoration project on Oakdale Ranch.

Oakdale Ranch is home to the second oldest working ranch in Yolo County to be owned and operated continuously by the same family. The 400 acre ranch is located on the outskirts of Esparto, California, at the gateway the Capay Valley. The Stephens Family has owned and operated Oakdale Ranch since 1852. Today, John Stephens and his son grow walnuts on the property. Recently, the Stephens partnered with the California Audubon's Landowner Stewardship Program to restore a portion of Willow Slough, re-grading and re-vegetating the banks to filter runoff, convey drainage, absorb floods, and provide a habitat corridor for riparian species that the Stephens remember once inhabiting the area.

John Stephens originally approached Audubon California with the idea of restoring wildlife habitat on his land. Early on, all parties agreed that improving flood control and water conveyance along the one-mile stretch of Willow Slough where it crosses the ranch was also a priority. Each winter the incised slough flooded fields and a nearby highway and required reshaping with heavy machinery. The maintenance was costly for Stephens, the local water district and the neighboring town of Madison. Thus, the project was designed to achieve multiple benefits: improving wildlife habitat and also minimizing harmful flooding. In the project's second year, Willow Slough's banks were sloped back, rising gently above the channel, mimicking a natural floodplain and re-vegetated with native plants (EDF 2005). Stephens enthusiastically describes the teams of teenagers that came out to plant the native vegetation through the Student and Landowner Education and Watershed Stewardship program (SLEWS). SLEWS engages California high school students in habitat restoration projects that enhance classroom learning, develop leadership skills and result in real positive impact for the environment.

According to Stephens, the project has worked out well: “To my neighbors and fellow farmers, obviously they’ve been looking over the back fence watching what’s going on over here and I’ve started to get more and more questions – what do you think? Did it work? Is it working out for you? And I have nothing to say but positive [things] about the situation. I don’t think it cannot work. It helps the drainage, which most farmers are worried about draining off their property. Is it helping the water quality? Yes, we’re starting to see that already. And as far as wildlife, it’s going to take two or three years to see how they’ll come back and if we can go out on those pheasant hunts again.”

Figure 3. Willow Slough on Oakdale Ranch before the project (left, an incised drainage ditch with steep banks covered in non-native vegetation) and after (right, more gently sloped banks provide a lower bench for high floods covered in native grasses and an upper bench with a maturing riparian forest).
Source: EDF 2005

Nearly six years later, the project has developed into a well-established riparian forest. Mature elderberries loaded with fruit, 15-foot tall cottonwoods, a variety of willows, and mulefat line the waterway. An understory of native rose, coyote bush, and coffee berry provide year-round food for wildlife from both the fruit they produce as well as the insects attracted to their flowers. Extensive stands of native perennial grasses and sedges provide year-round ground cover and continue to spread, securing the banks of the waterway, and filtering runoff before it enters the slough. Stephens says that the restoration process has been adaptive and that the second phase of the project was designed a bit differently based on what they learned from the first phase: “This [second phase of planting] was designed to keep some of the trees up off the banks a little higher since we found out some of the trees were plugging off the stream…We have done some learning and the Audubon found some things out, which is really good, so some of the other projects that I hope they do in Yolo County can use this as a model” (Figure 4).

Conclusion

Figure 4. John Stephens showing the second phase of the Willow Slough restoration project on Oakdale Ranch
Source: Rich Panter

Today, Stephens reports considerable improvements in Willow Slough's water quality. In addition, wildlife has gradually returned to the banks, including a beaver, quail and pheasants. Stephens is currently planning to expand the restoration project another half mile, in cooperation with CalTrans. Stephens notes the project requires on-going maintenance to ensure that non-native species do not return and that flood flows continue to be conveyed quickly downstream. "You have to be committed...The ongoing grants that we thought maybe would come from the government or the state are not there, so we more or less have to take it up ourselves," according to Stephens. But the payoff is considerable; Stephens hopes to soon introduce his grandchildren to the pheasant hunts that he so fondly remembers from his own childhood on the ranch. In the future, Stephens hopes that his riparian restoration project will be linked to other riparian projects that will create a riparian corridor along the length of Willow Slough. The availability of programs to help offset the costs of design installation and maintenance will be key.

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Riparian restoration schedule for Scott River- Revised January 2014

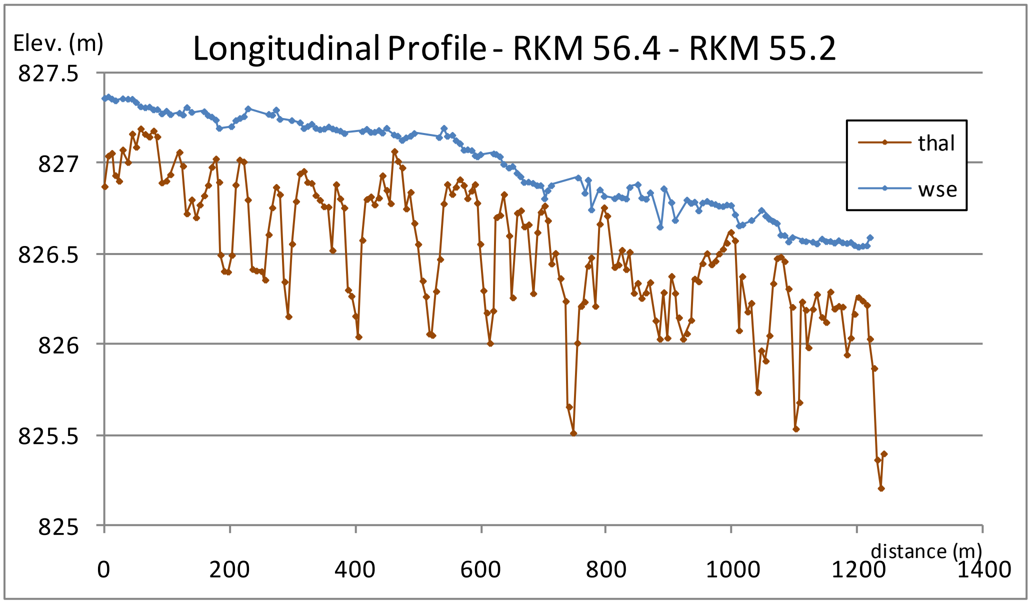
Task	Location	Status
Reach I. (Callahan to end of tailings)		
Completion of geomorphic analysis	**No recommendations until further ge**	
Seek funding for geomorphic analysis		
Reach II. (End of tailings to SVID)		
Bioengeneered streambank	RM 48 across from French Creek	Funded
Bioengeneered streambank	River Mile 52	In -development
Maintence of previous planting (caging, etc)	Wolford Slough area (RM 48)	In progress
Planting implementation	East Bank Scott Across from French Creek & south (~RM 48 miles)	In progress
Planting implementation	West bank Scott at RM 48 , vicinity of Wolford Slough	In progress
Maintenance	All plantings	annual
Planting implemetation -10 acres	As locations are identified.	seek funding
Reach III. SVID to 1.5 Miles downstream of Etna Creek		
Planting implementation	Scott at RM 40.4	Funded
Maintenance	All plantings	annual
Planting implemetation -10 acres	As locations are identified.	seek funding
Reach IV. Etna Creek to Oro Fino Creek		
Bioengeneered streambank	Scott at RM 41	In -development
Maintence of previous planting	Scott at RM 42	ongoing
Bioengeneered streambank	Scott at RM 36	Funded
Planting implementation	Scott at RM 39	Funded
Planting implementation	Scott at RM 36	Funded
Reach V. Oro Fino Creek to end of Valley		
Hand thinning of arroyo willow and selected planting of cottonwood and alder.	varied through reach, as landowners are identified.	in development
Identify potential planting locations		

Planting implemetation -10 acres	As locations are identified.	seek funding
Tibutaries		
Geomorpic survey and analysis of Patterson,Kidder, Etna Creek in alluvial sections.		
French Creek	As locations are identified.	seek funding
Etna	As locations are identified.	seek funding
Shackleford	As locations are identified.	seek funding
Kidder	As locations are identified.	seek funding
East Fork	As locations are identified.	seek funding
Moffett	As locations are identified.	seek funding

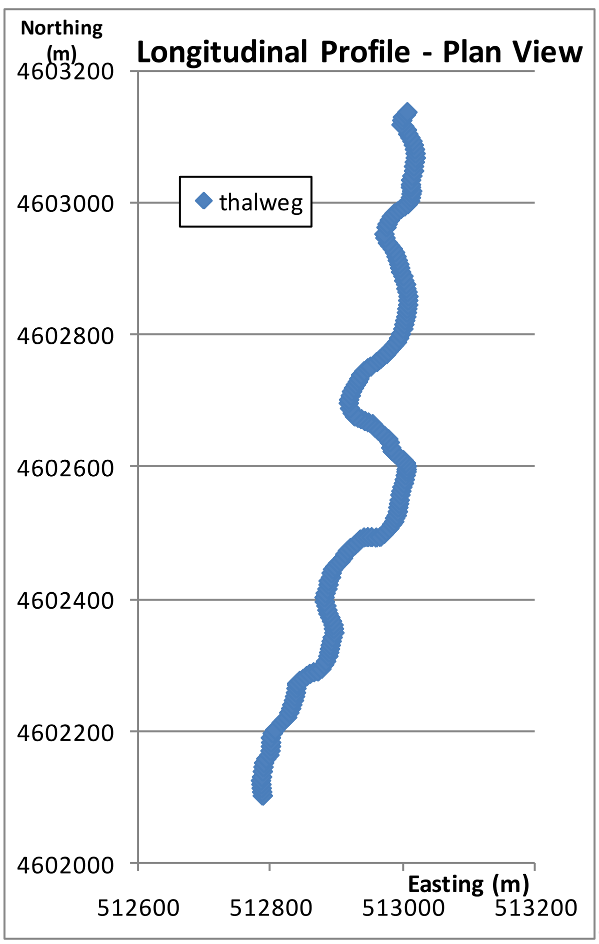
Timeframe
omorphic analysis is completed.
as potential funding sources are identified.
Completed October 2013
Fall 2014?
Fall 2012
Fall 2012
Fall 2012
annually
annually
Fall 2013
annually
annually
Fall 2015
ongoing by landowner
Completed October 2013
Fall 2013
Fall 2013
Fall 2013, Fall 2014
Annually

annually
when funding available
as identified & funding is available
as identified & funding is available
as identified & funding is available
as identified & funding is available
as identified & funding is available
as identified & funding is available

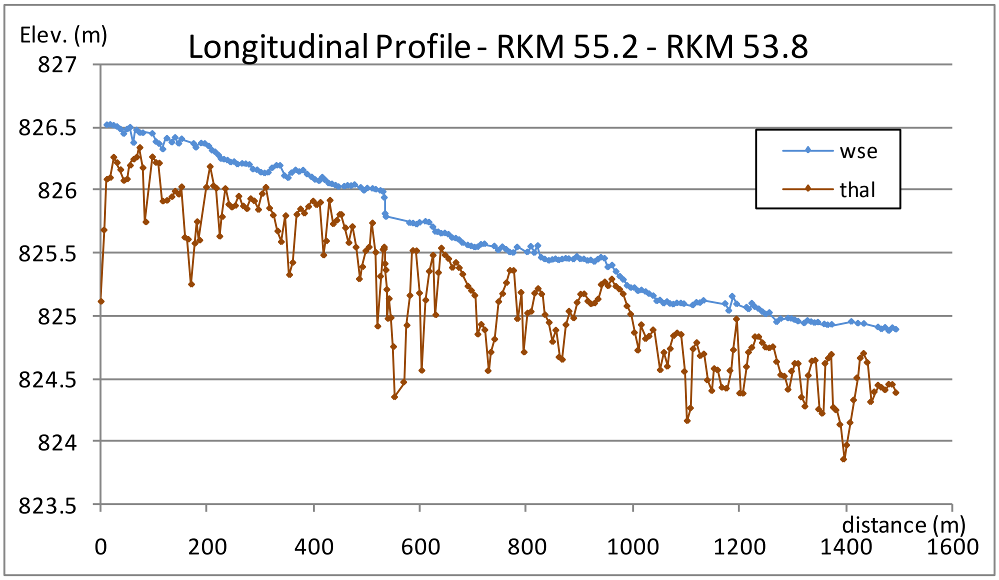
Geomorphic Survey – Scott River RKM 56.4 – 53.8



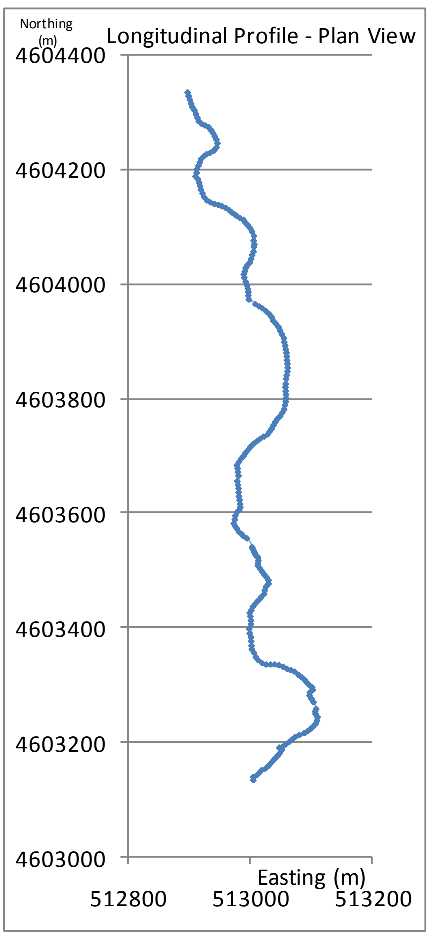
Graph 1 – Longitudinal profile of the Scott River thalweg – RKM 66.5 – 65.3



Graph 2 – Plan View of longitudinal profile



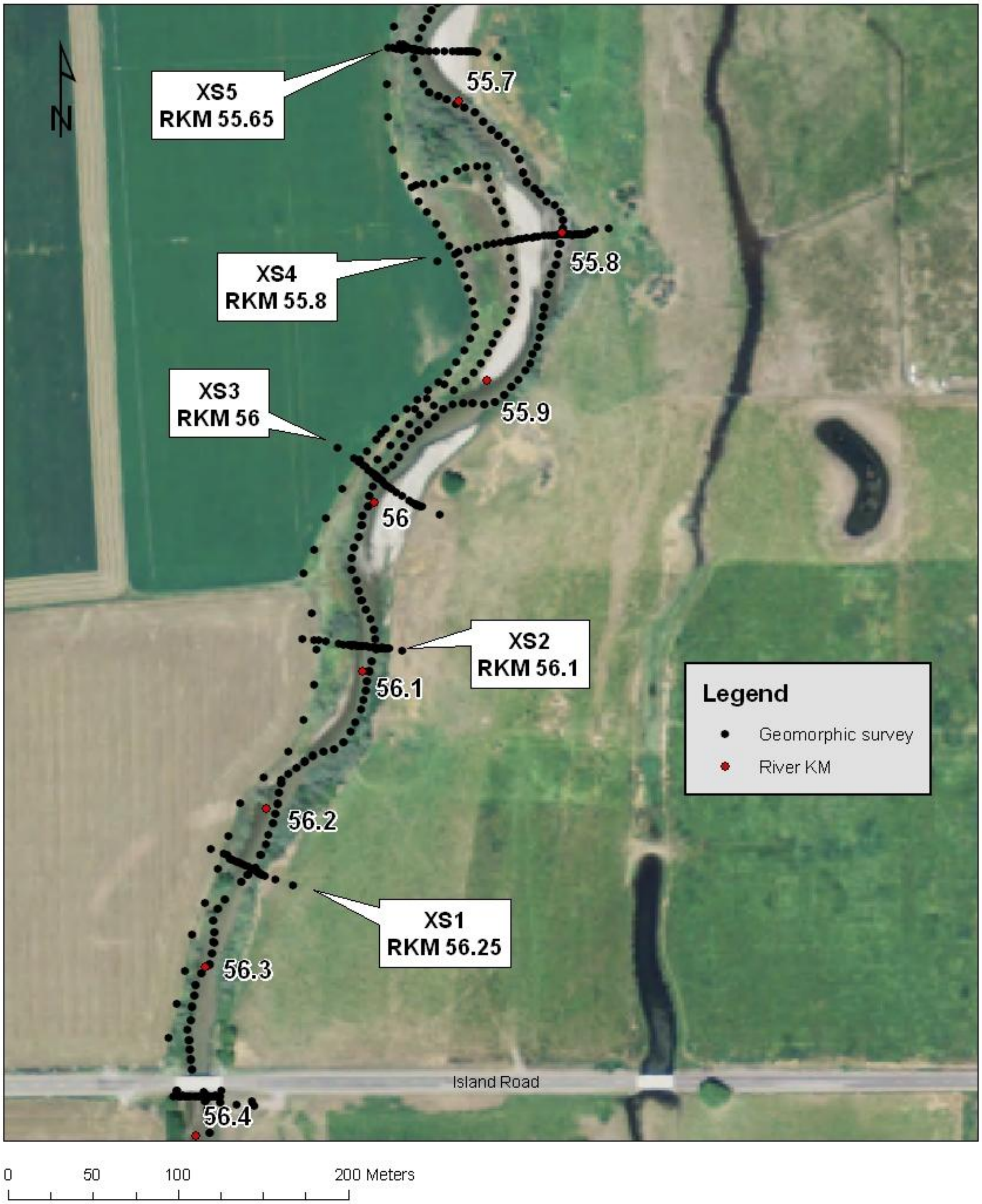
Graph 3 – Longitudinal profile of the Scott River thalweg – RKM 55.2 – 53.8



Graph 4 – Plan View of longitudinal profile

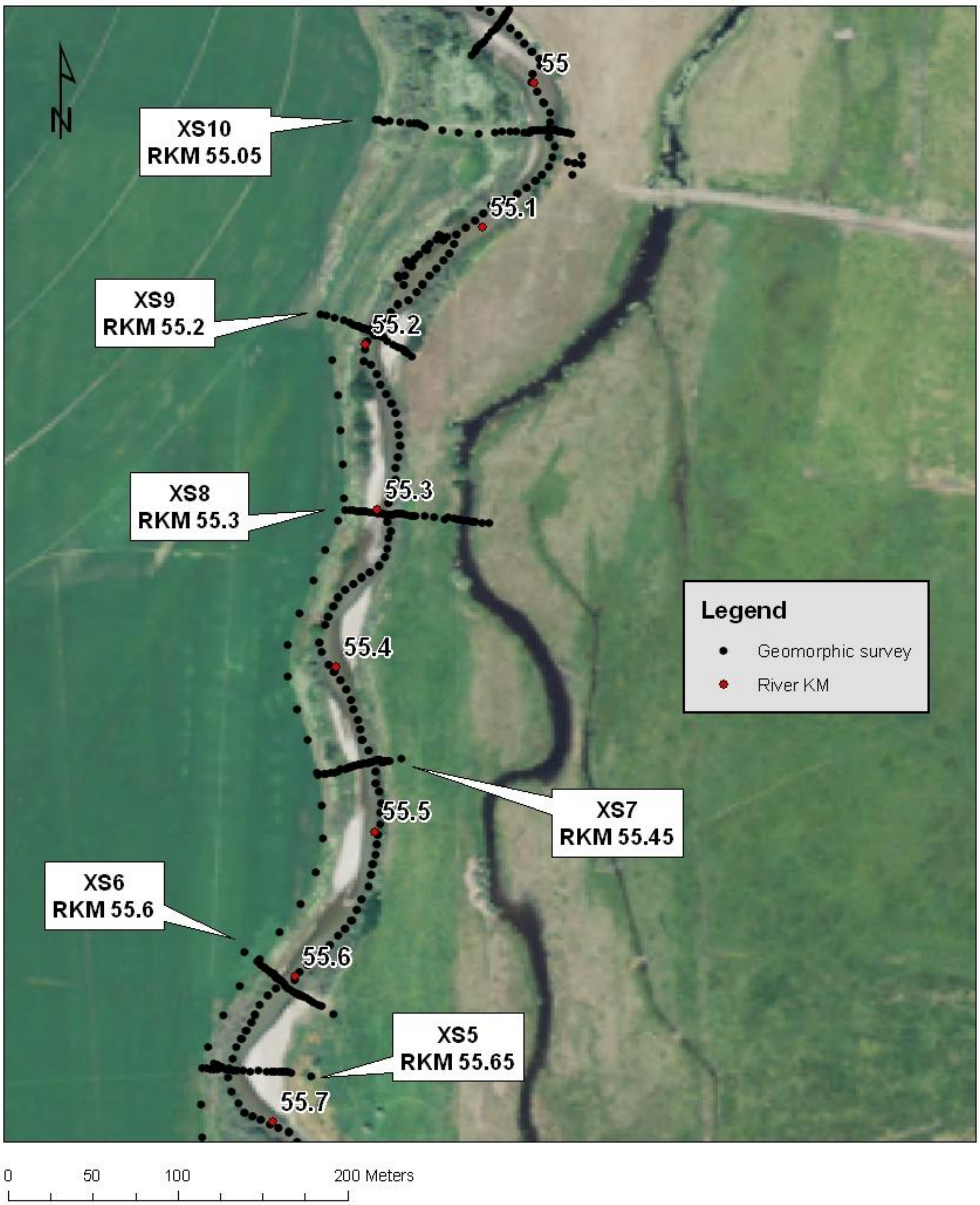
The surveyed reach was approximately 0.07% in slope from RKM 56.4 – 55.2 and 0.12% in slope from RKM 55.2 – RKM 53.8.

Scott River Geomorphic Survey - RKM 56.4 - 53.8



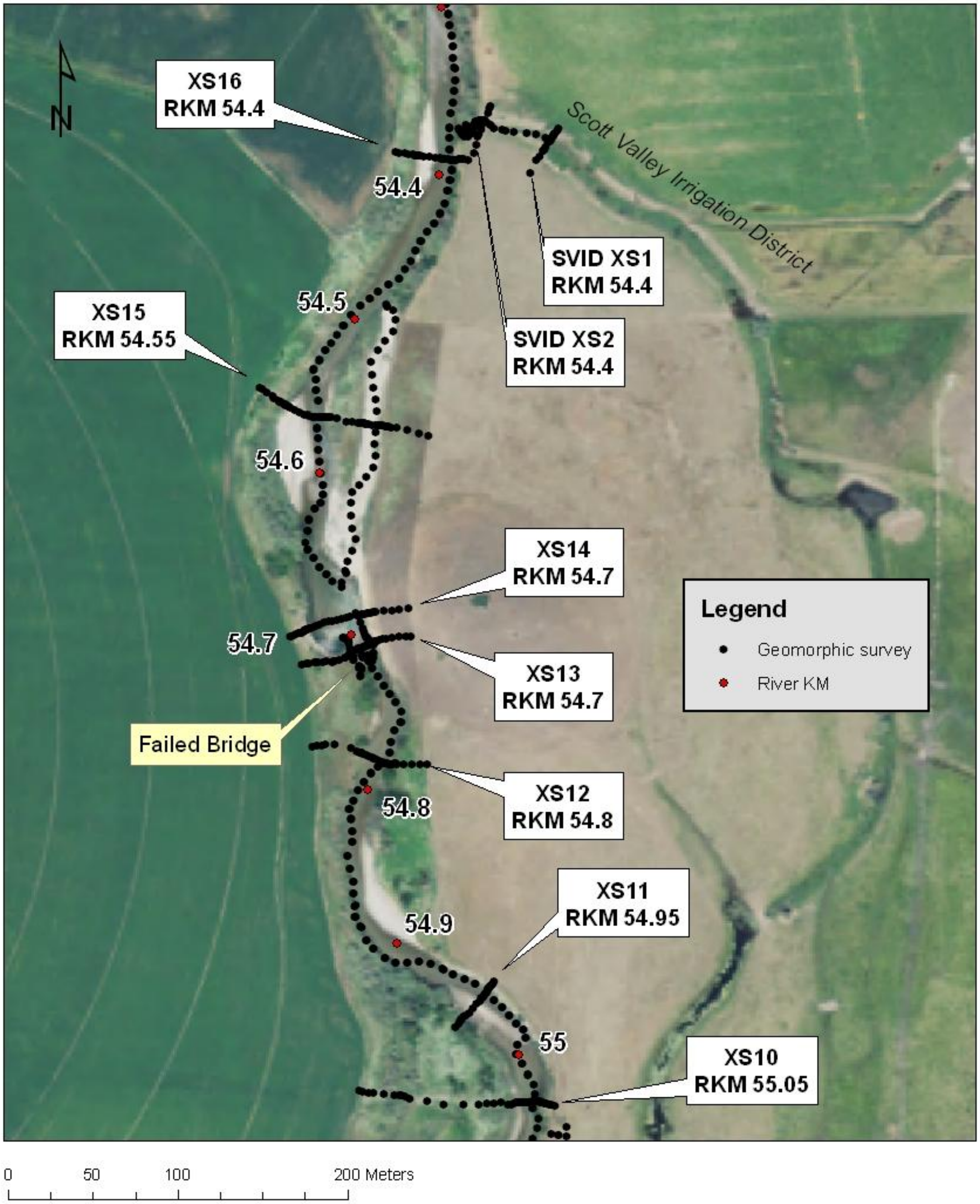
Map 1 – up stream portion of surveyed reach – RKM 56.4 – RKM 53.8

Scott River Geomorphic Survey - RKM 56.4 - 53.8



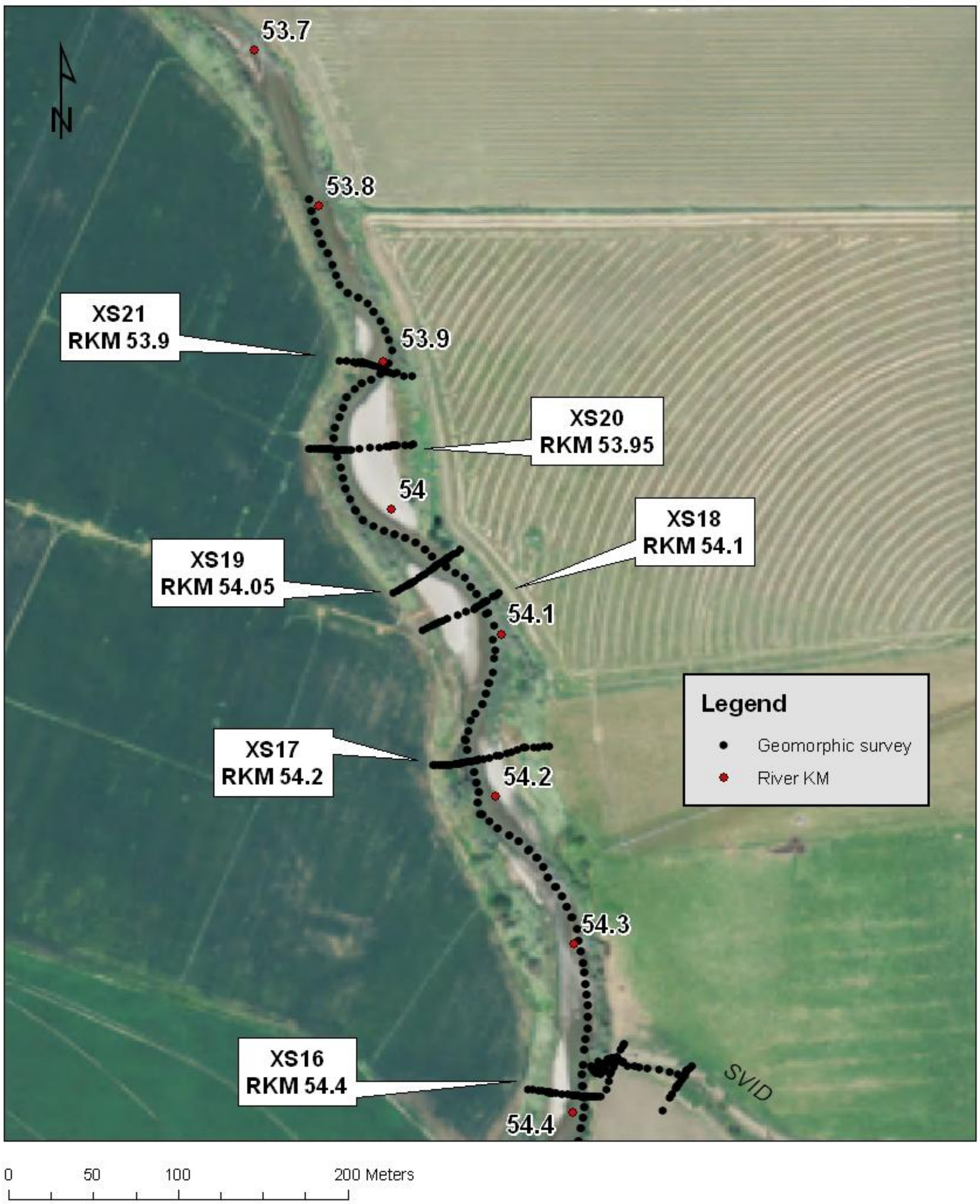
Map 2 – up stream portion of surveyed reach – RKM 56.4 – RKM 53.8

Scott River Geomorphic Survey - RKM 56.4 - 53.8



Map 3 – downstream portion of surveyed reach – RKM 56.4 – RKM 53.8

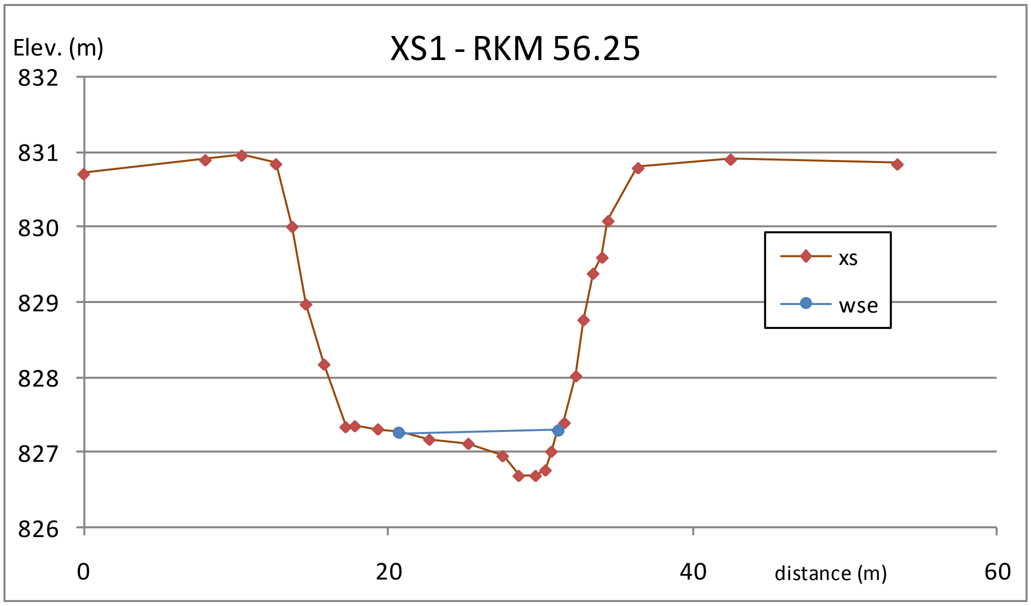
Scott River Geomorphic Survey - RKM 56.4 - 53.8



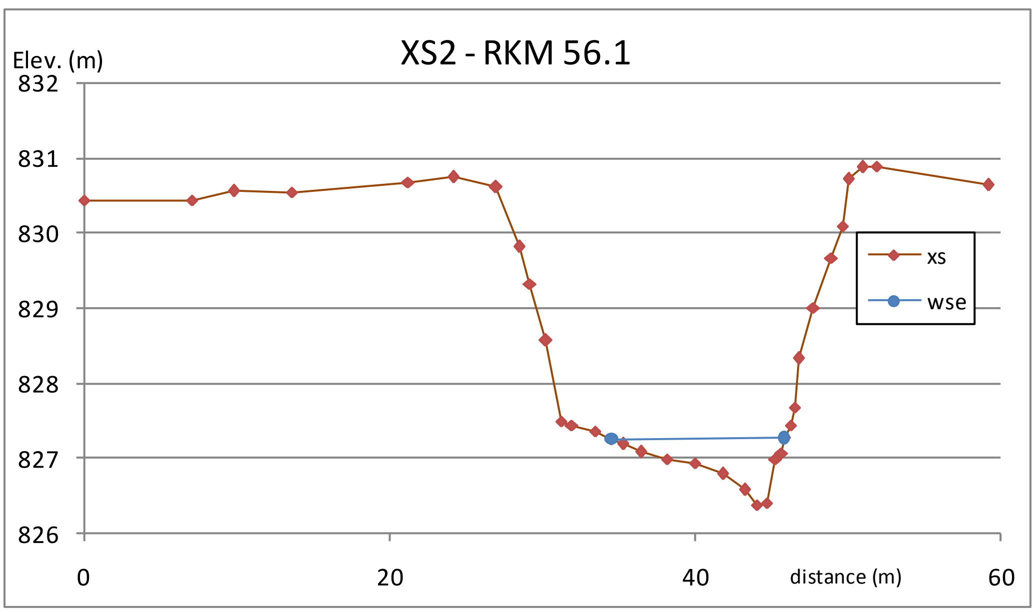
Map 4 – downstream portion of surveyed reach – RKM 56.4 – RKM 53.8

Stream KM	Potential Shade	Current Shade	Potential Shade Increase
56.4	0.51	0.32	0.19
56.3	0.6	0.13	0.47
56.2	0.5	0.12	0.38
56.1	0.61	0.18	0.43
56	0.28	0.01	0.27
55.9	0.48	0.08	0.4
55.8	0.37	0.03	0.34
55.7	0.5	0.32	0.18
55.6	0.49	0.1	0.39
55.5	0.39	0.02	0.37
55.4	0.59	0.1	0.49
55.3	0.39	0.02	0.37
55.2	0.38	0.02	0.36
55.1	0.49	0.16	0.33
55	0.39	0.1	0.29
54.9	0.4	0.09	0.31
54.8	0.58	0.1	0.48
54.7	0.19	0.04	0.15
54.6	0.26	0.09	0.17
54.5	0.39	0.11	0.28
54.4	0.5	0.03	0.47
54.3	0.5	0.16	0.34
54.2	0.4	0.11	0.29
54.1	0.4	0.03	0.37
54	0.4	0.08	0.32
53.9	0.6	0.04	0.56
53.8	0.51	0.1	0.41

Table 1 – Potential and current shade from NCRWQCB Staff Report for Scott River TMDL

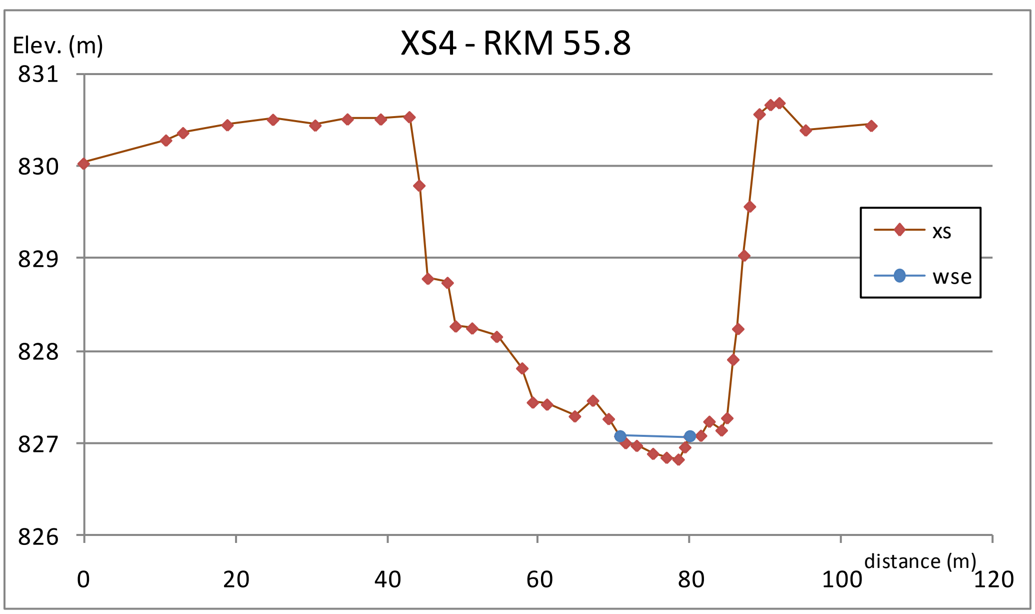


Graph 5 – XS1 at RKM 56.25



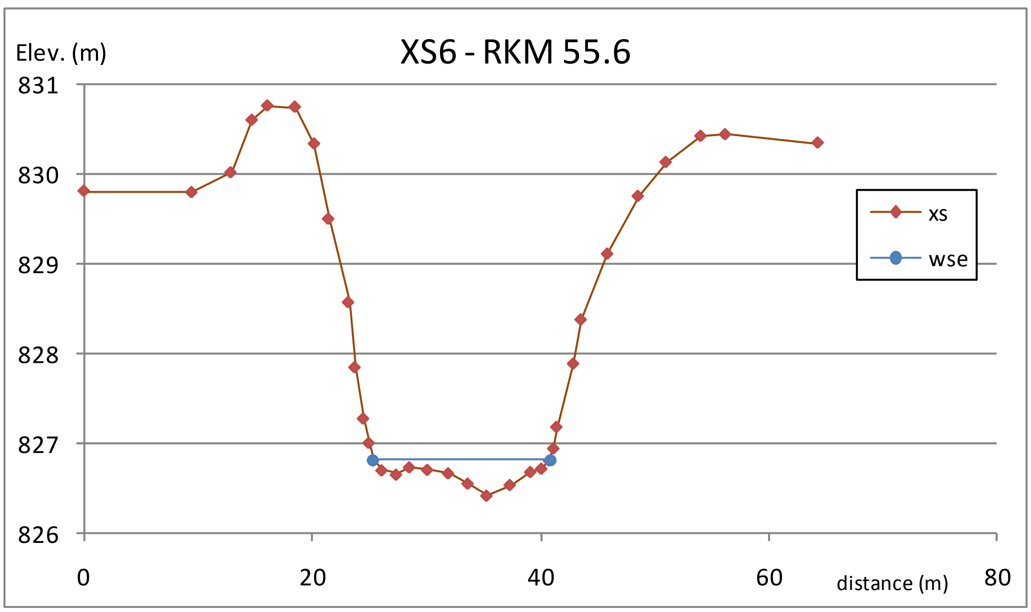
Graph 6 – XS2 at RKM 56.1

Graph 7 – XS3 at RKM 56



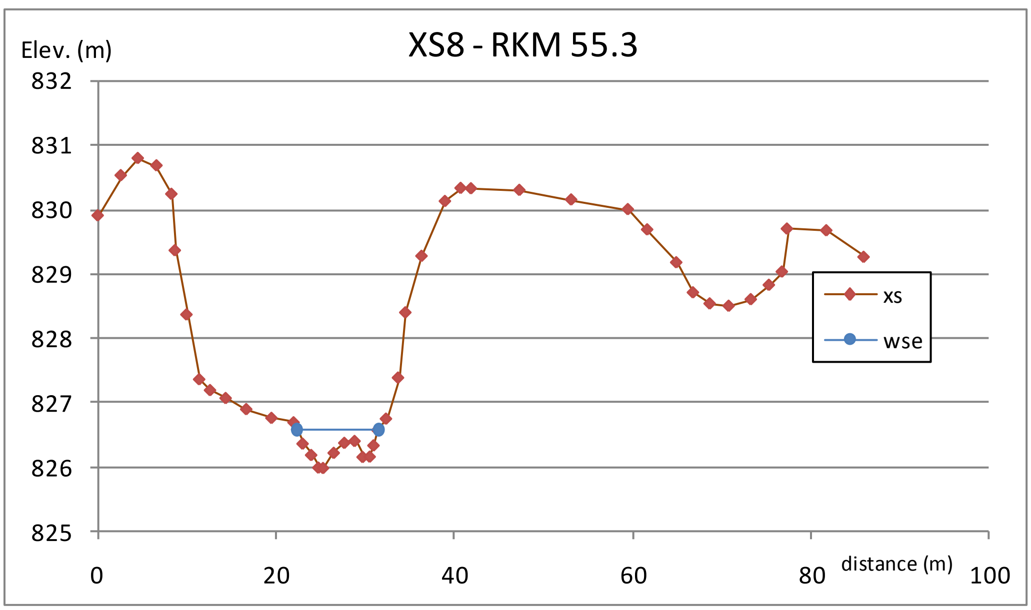
Graph 8 – XS4 at RKM 55.8

Graph 9 – XS5 at RKM 55.65



Graph 10 – XS6 at RKM 55.6

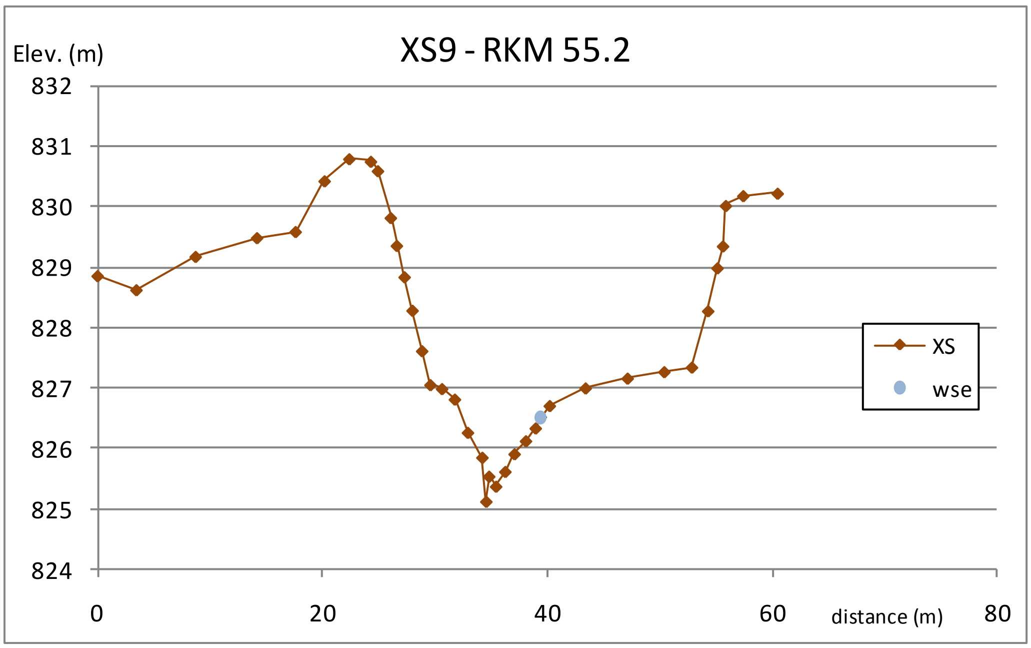
Graph 11 – XS7 at RKM 55.45



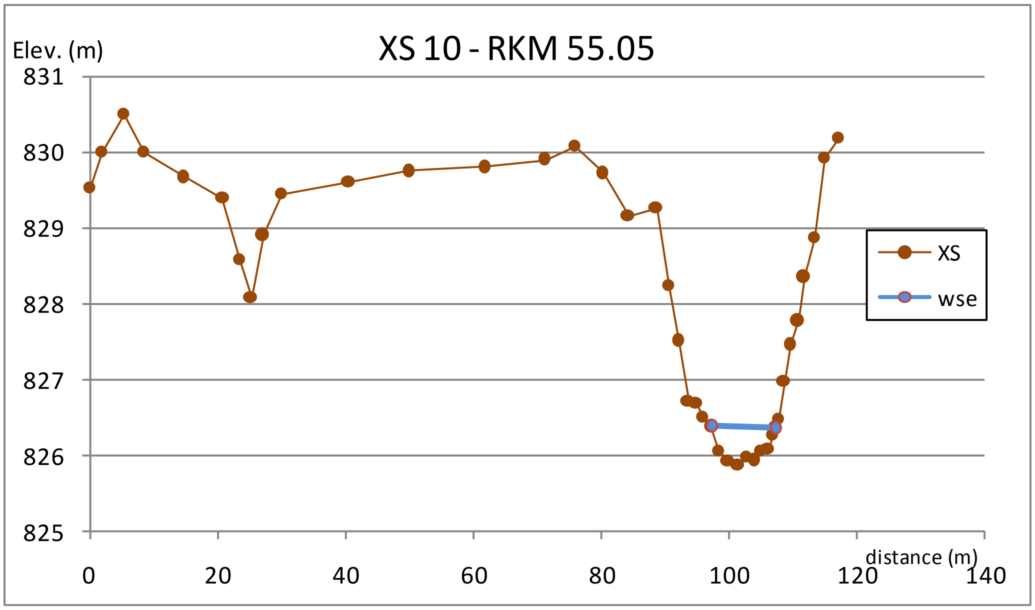
Graph 12 – XS8 at RKM 55.3

X-section	RKM	Left Bank Height	Right Bank Height	Thalweg to Left Bank	Thalweg to Right Bank	Left Bank to Right Bank
1	56.25	4.2	4.1	17	6.7	23.7
2	56.1	4.2	4.3	17.1	6	23.1
3	56	4.9	4.4	8.2	29.1	37.3
4	55.8	3.7	3.7	35.5	10.7	46.2
5	55.65	5.1	4.7	9	33.2	42.2
6	55.6	3.6	3.7	9.9	24	33.9
7	55.45	3.3	3.6	15.2	11.2	26.4
8	55.3	4.3	4.1	17	13.7	30.7
		4.2	4.1			32.9

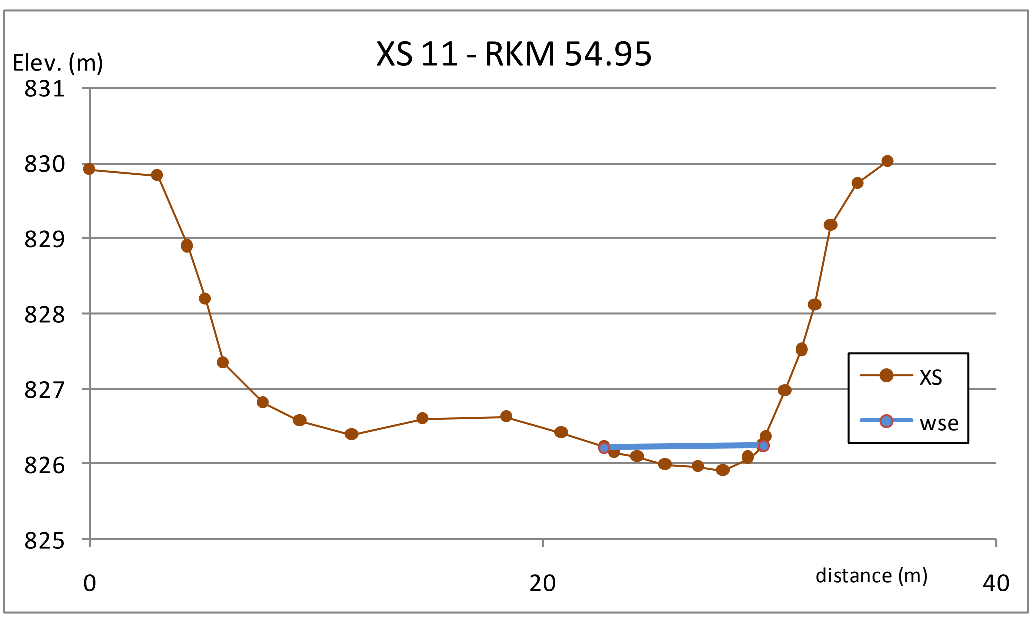
Table 2 – bank height and channel width (meters)



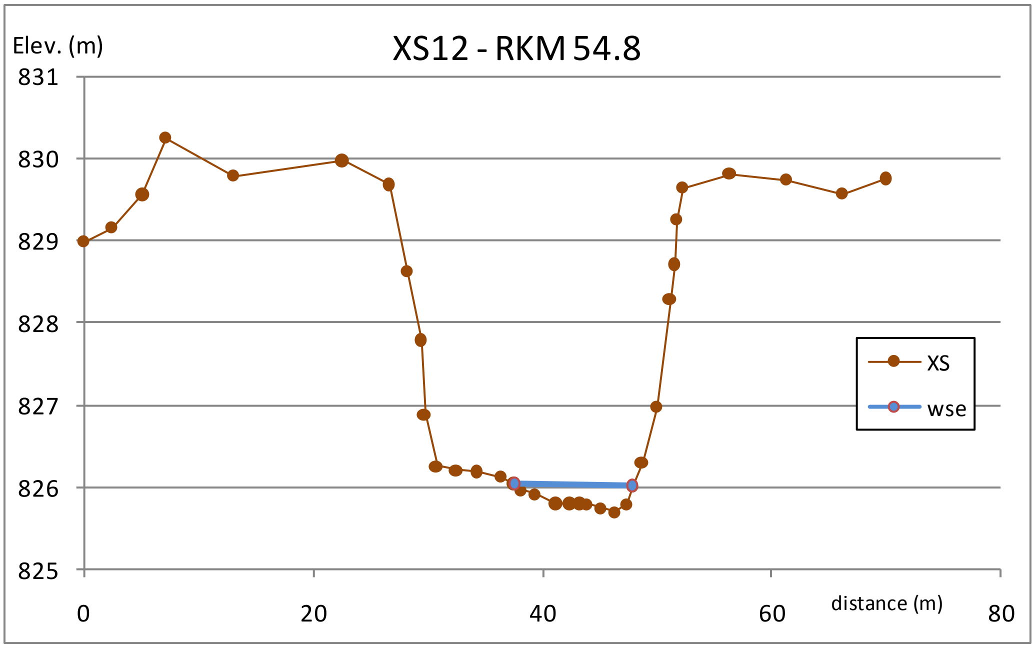
Graph 13 – XS9 at RKM 55.2



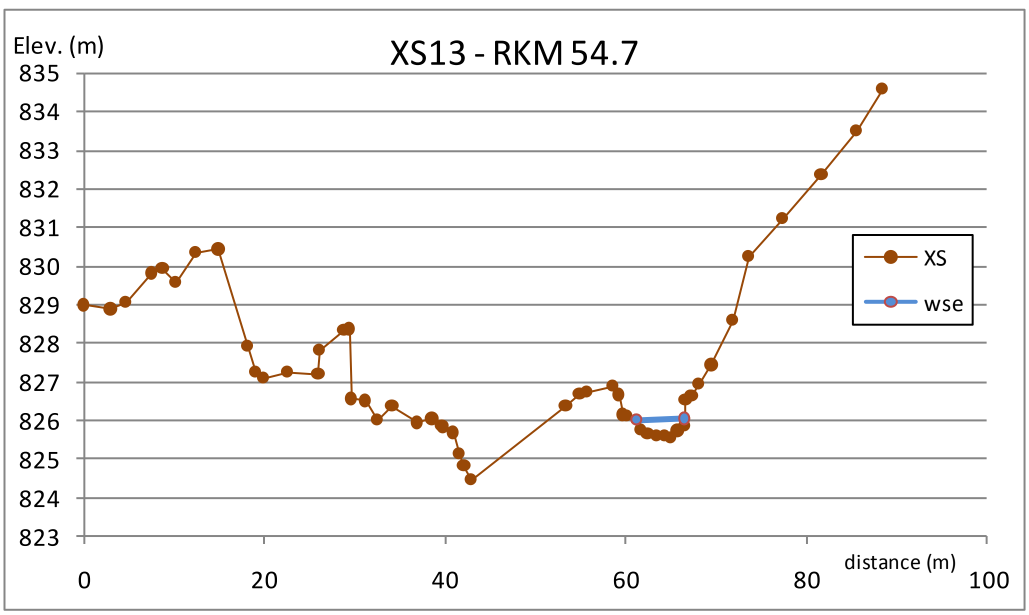
Graph 14 – XS10 at RKM 55.05



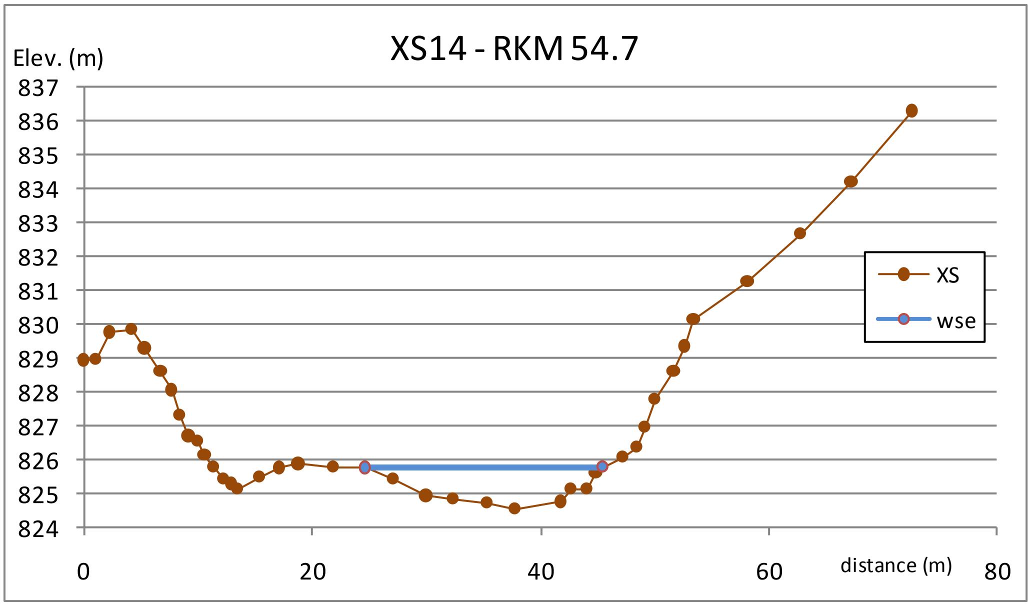
Graph 15 – XS11 at RKM 54.95



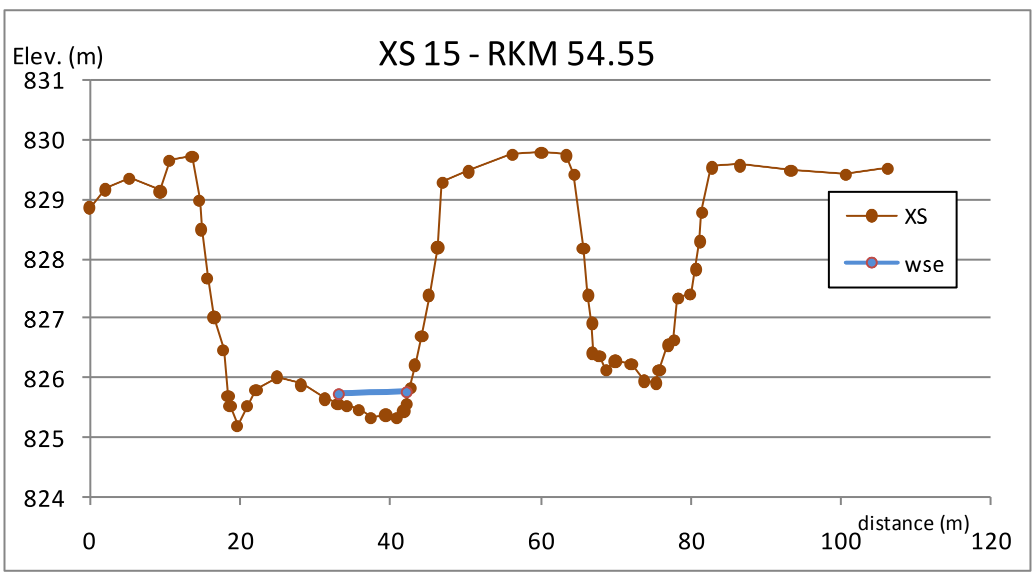
Graph 16 – XS12 at RKM 54.8



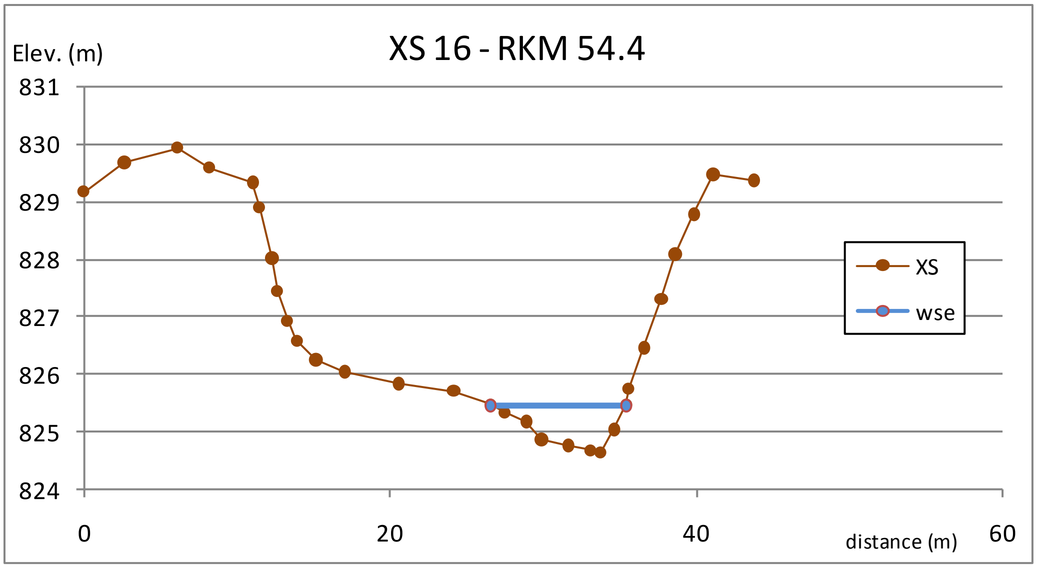
Graph 17 – XS13 at RKM 54.7



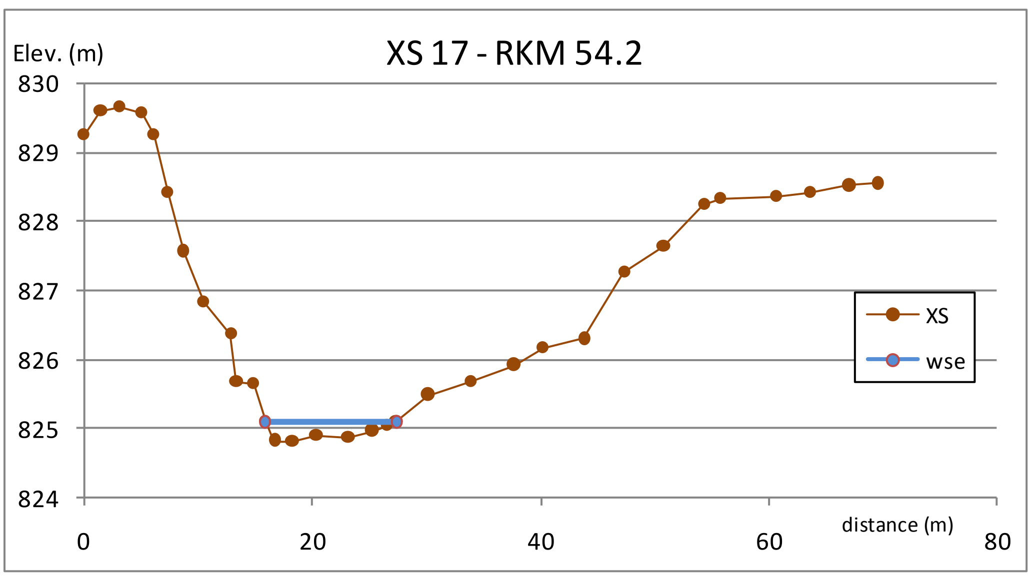
Graph 18 – XS14 at RKM 54.7



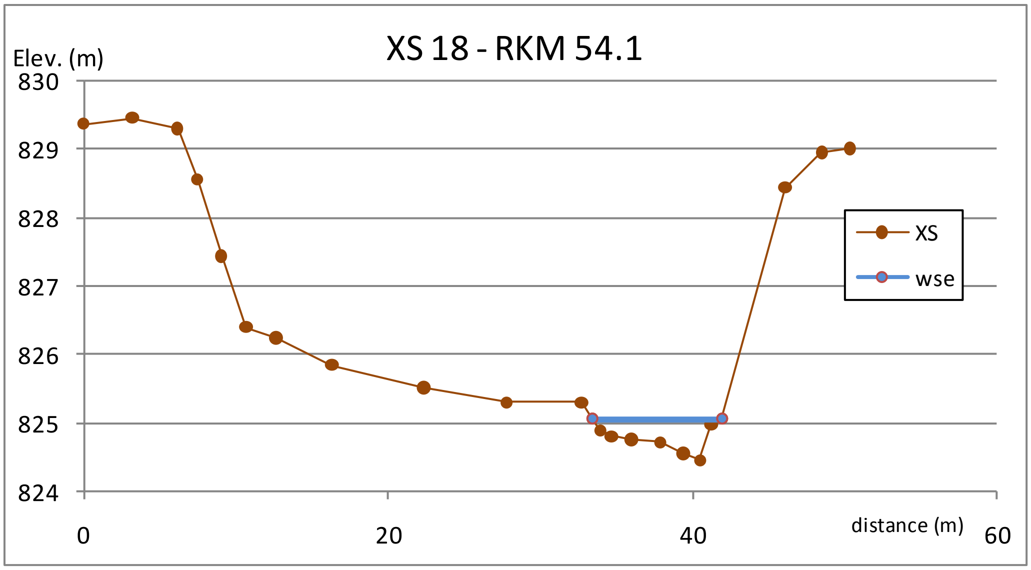
Graph 19 – XS15 at RKM 54.55



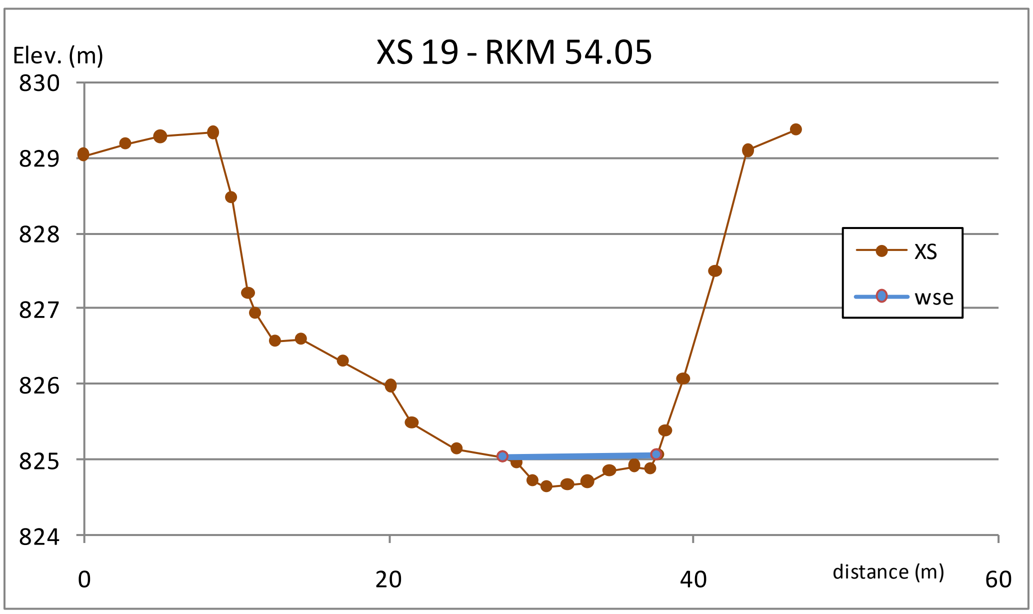
Graph 20 – XS16 at RKM 54.4



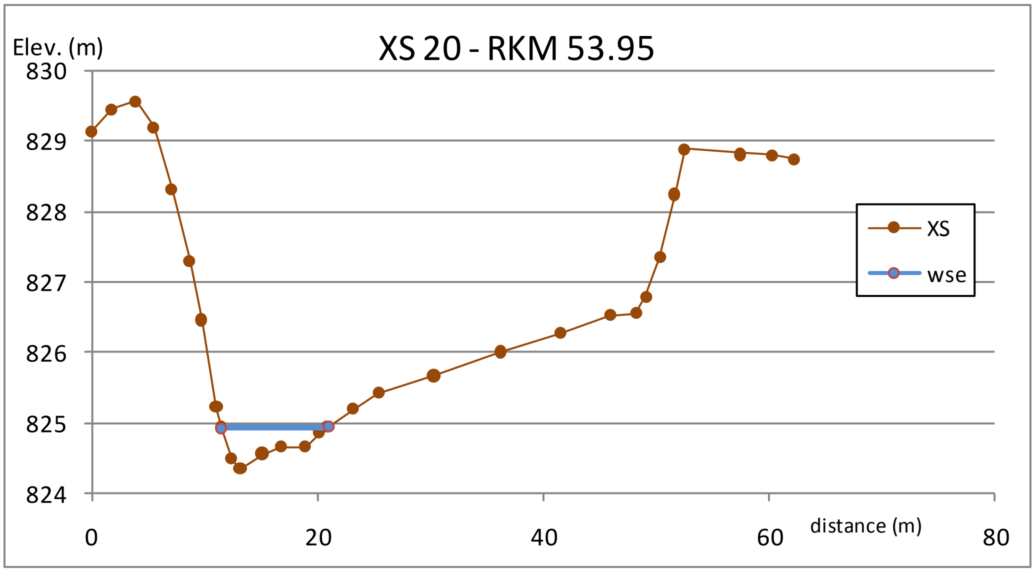
Graph 21 – XS17 at RKM 54.2



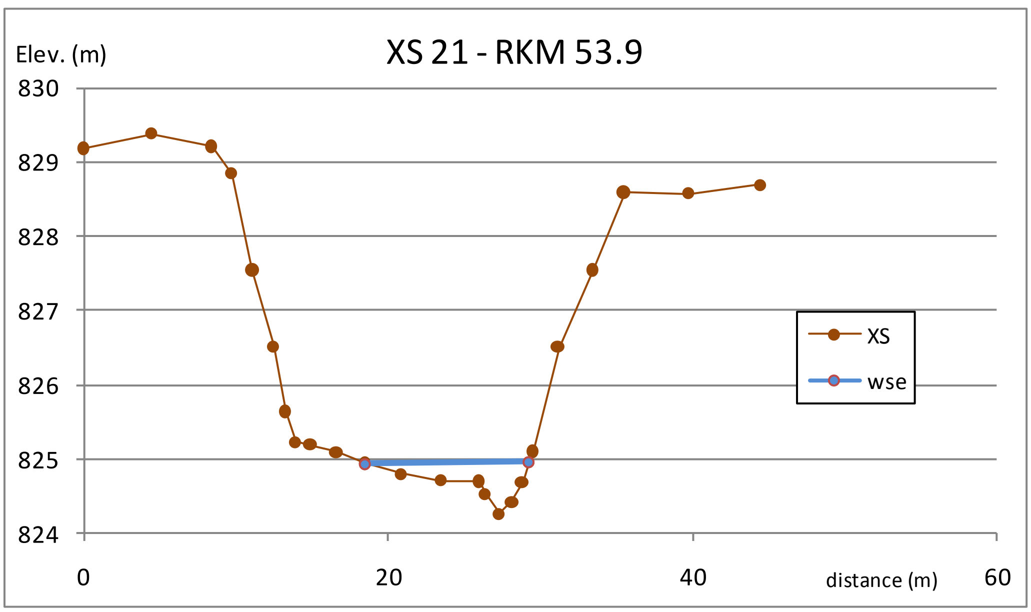
Graph 22 – XS18 at RKM 54.1



Graph 23 – XS19 at RKM 54.05



Graph 24 – XS20 at RKM 53.95



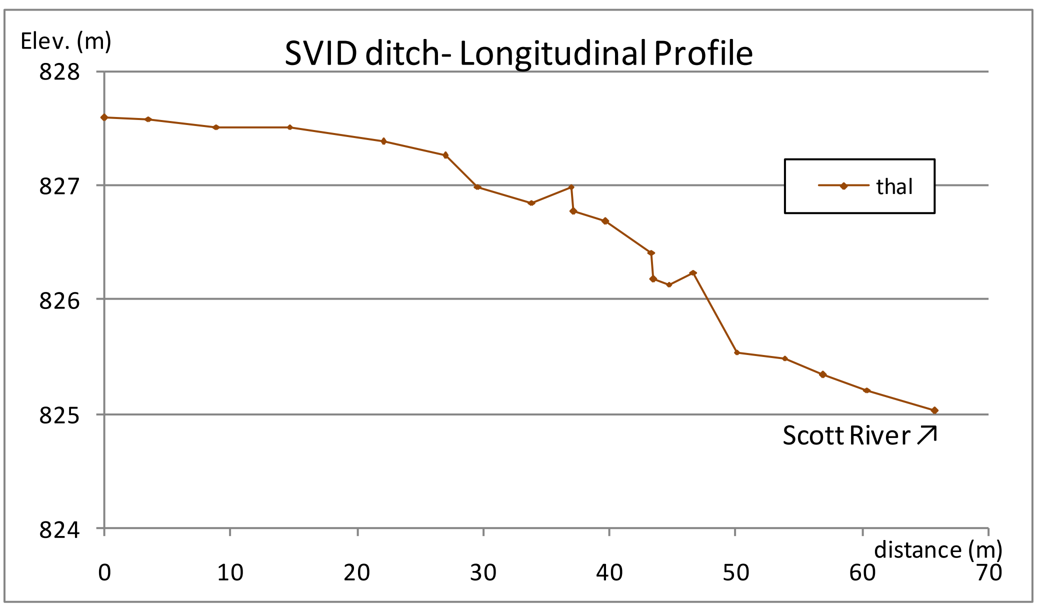
Graph 25 – XS21 at RKM 53.9

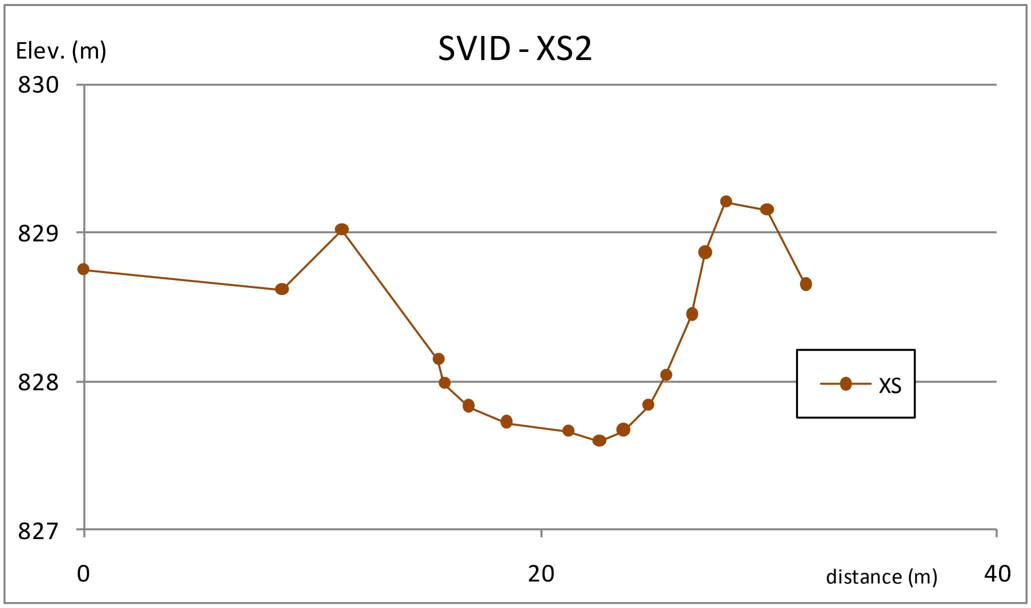
X-section	RKM	Left Bank Height	Right Bank Height	Thalweg to Left Bank	Thalweg to Right Bank	Left Bank to Right Bank
9	55.2	5.6	4.9	10.3	21.3	31.6
10	55.05	4.2	4	25.4	13.6	39
11	54.95	3.9	3.8	23.9	7	30.9
12	54.8	3.9	3.8	15.8	9.8	25.6
13	54.7	4.8	4.7	49.4	9.4	58.8
14	54.7	5.1	5.4	37.6	11.7	49.3
15	54.55	4.4	4	23.7	9.5	33.2
16	54.4	4.7	4.8	22	8	30
17	54.2	4.8	3.4	13.2	36.1	49.3
18	54.1	4.7	3.9	33.2	6.7	39.9
19	54.05	4.6	4.4	24.5	10.6	35.1
20	53.95	4.9	4.5	7.7	39.4	47.1
21	53.9	4.9	4.3	18.9	8.2	27.1
		4.7	4.3			38.2

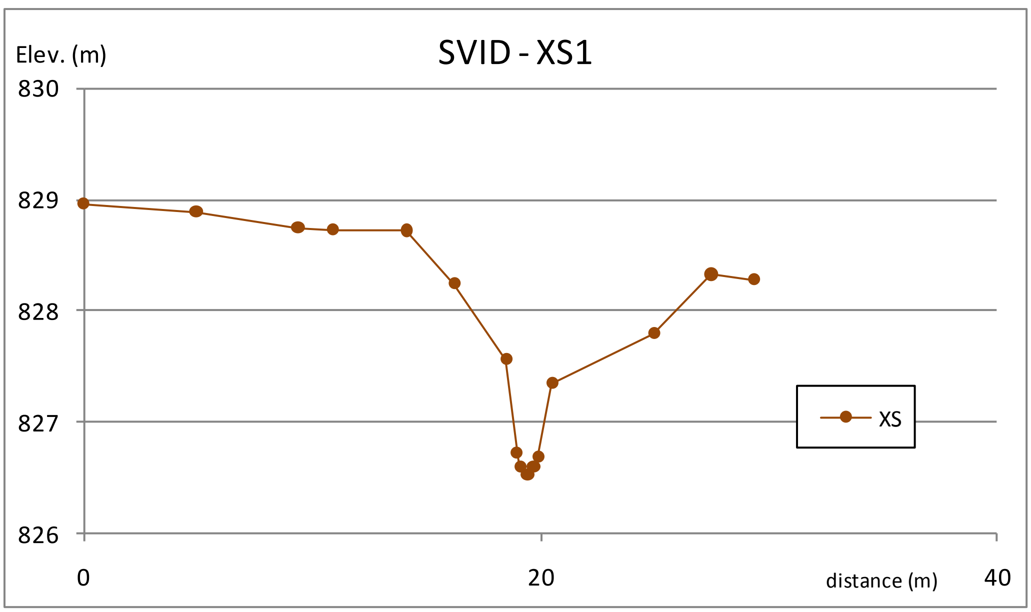
Table 3 – bank height and channel width (meters)

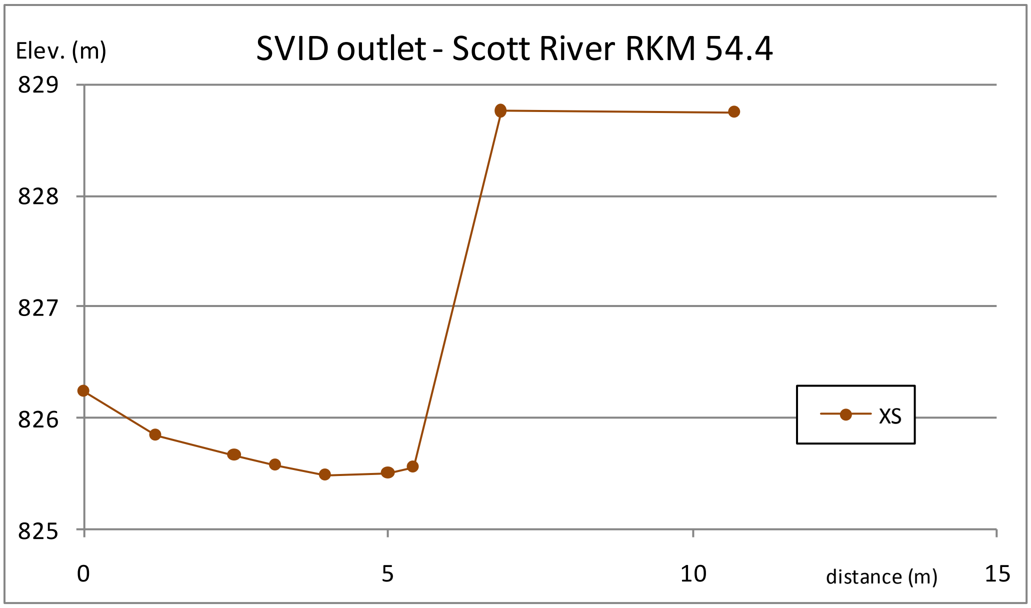
Scott Valley Irrigation District (SVID) Ditch

The SVID ditch enters the Scott River at RKM . A short longitudinal profile of the ditch's confluence with the Scott River and three cross sections were surveyed.




SVID - XS2
Elev. (m)
830
829
828
827
0
20
distance (m)
40
XS


SVID - XS1
Elev. (m)
830
829
828
827
826
0
20
distance (m)
40
XS

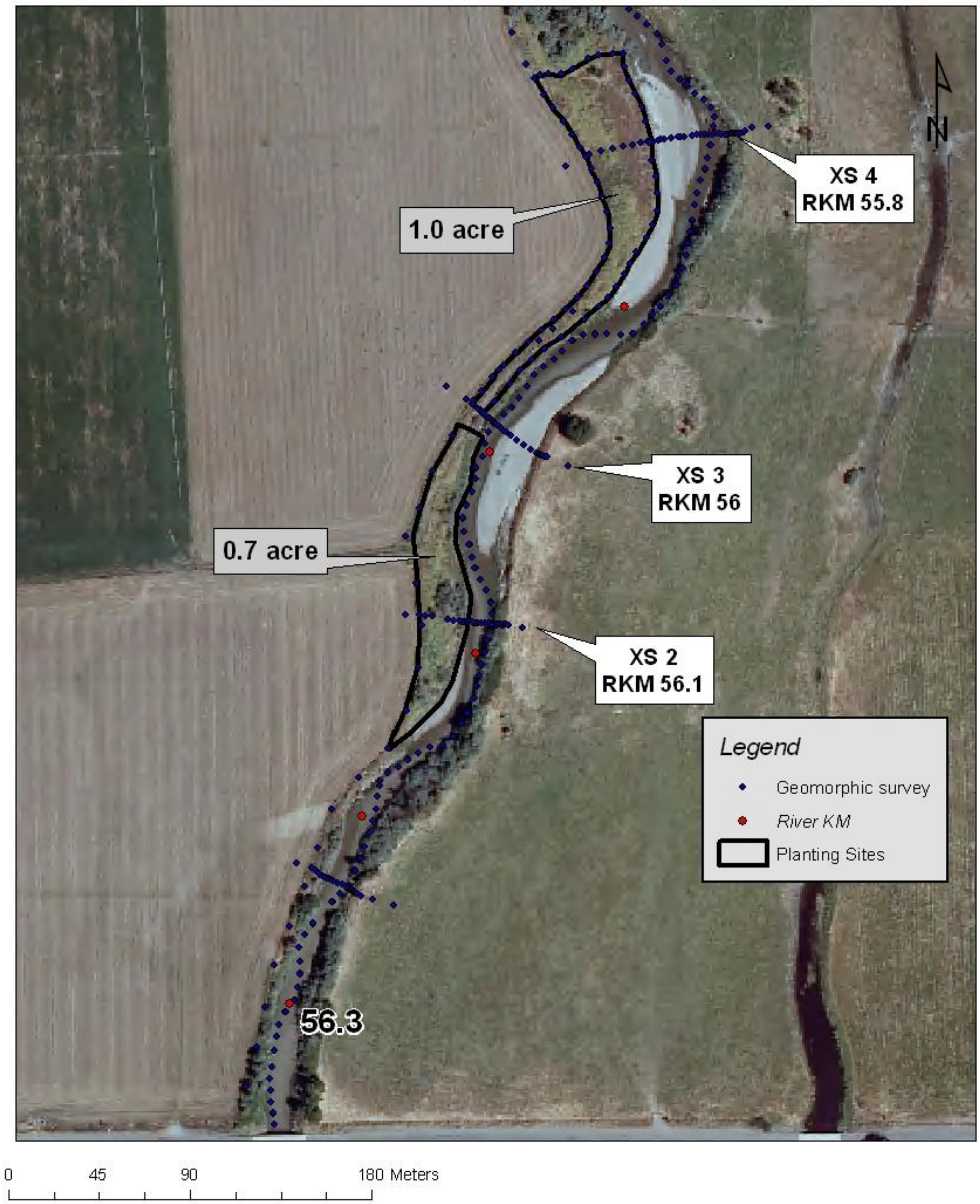


SVID outlet - Scott River RKM 54.4
Elev. (m)
829
828
827
826
825
0
5
10
15
distance (m)
XS

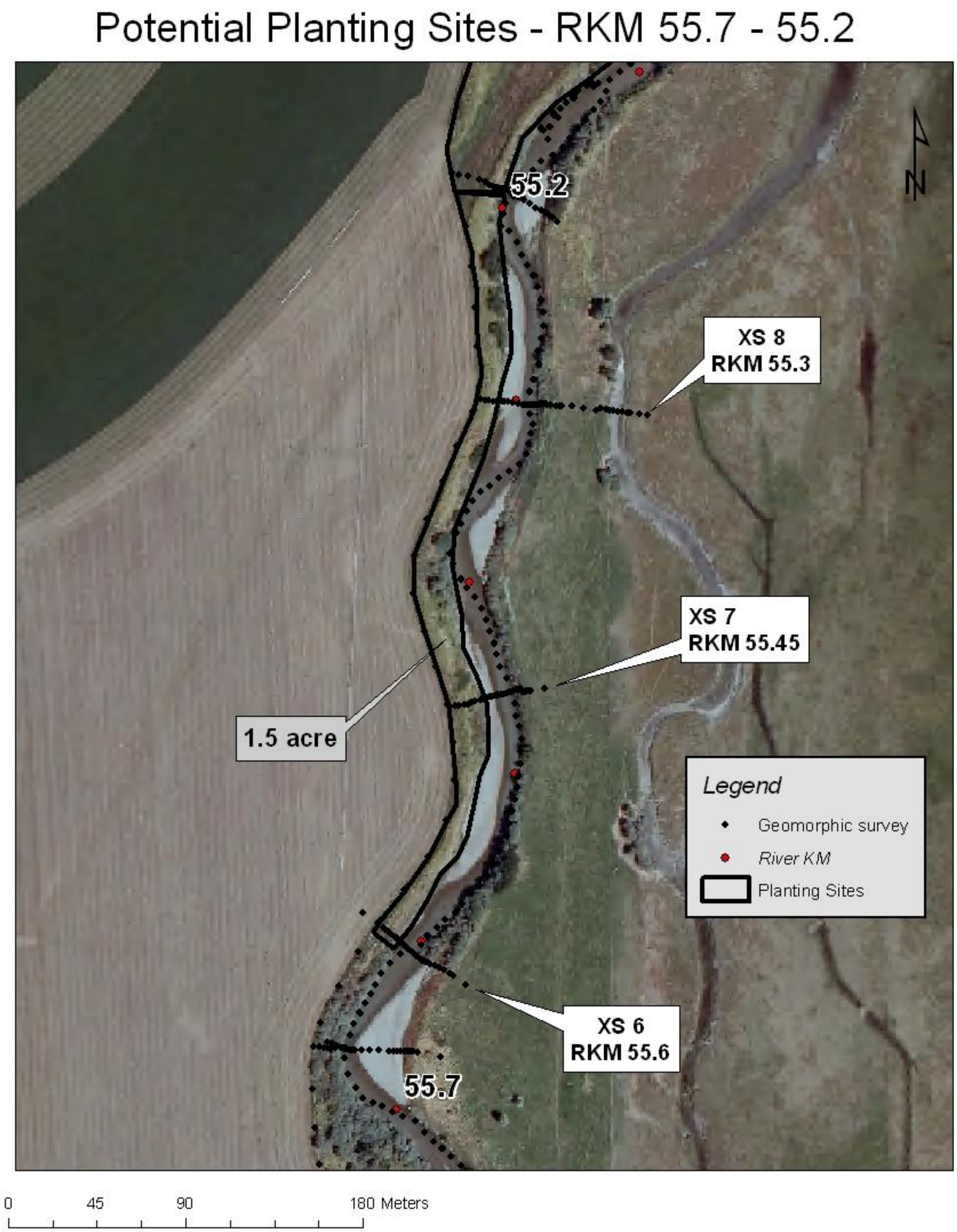
Scott River morphology - 1993 & 2010
RKM 54.8 - RKM 54.4

Map 5 – aerial images from 1993 and 2010 – site of failed bridge and “island”

Potential Planting Sites - RKM 56.3 - 55.9

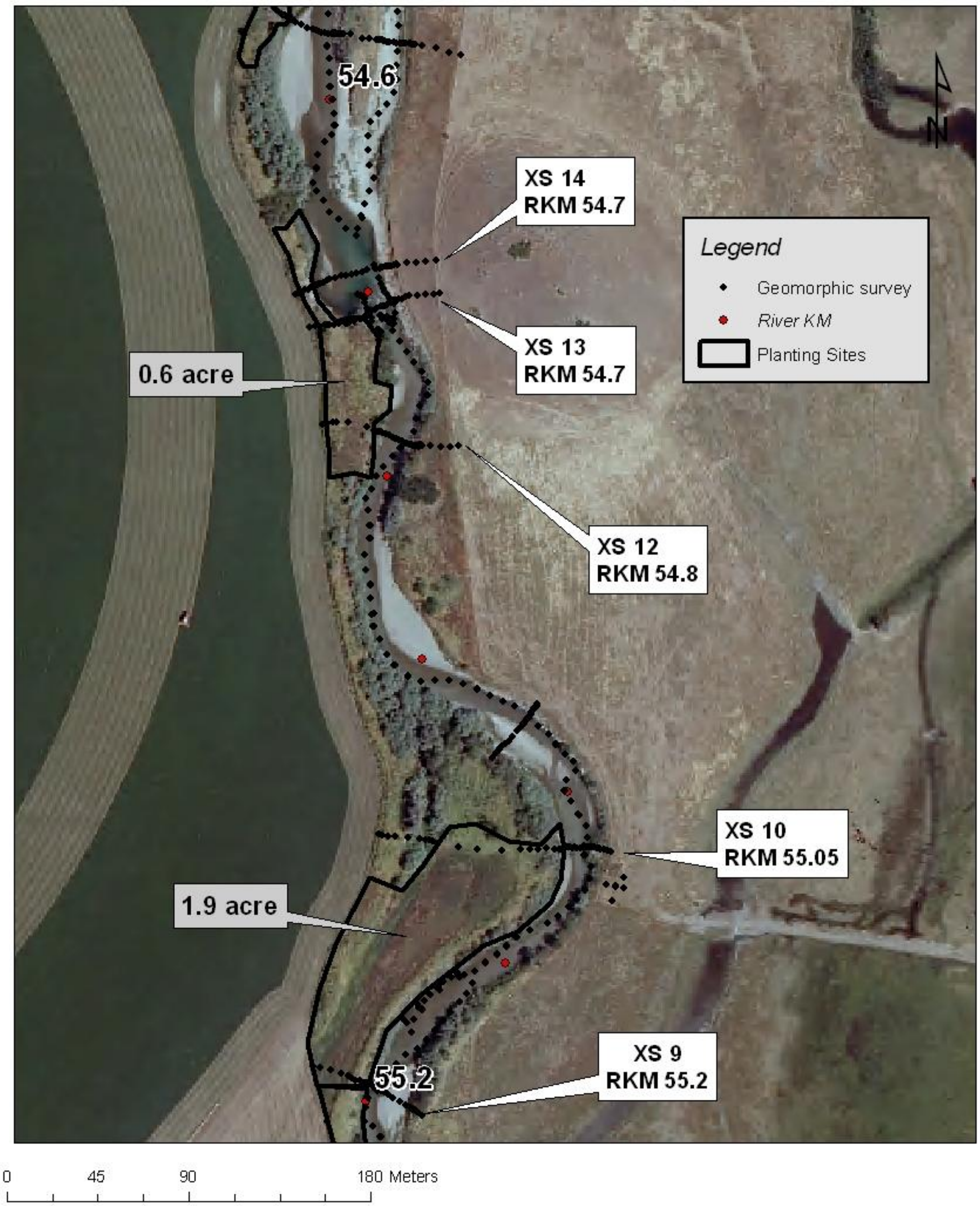


Map 6 – potential planting sites – RKM 56.3 – RKM 55.9



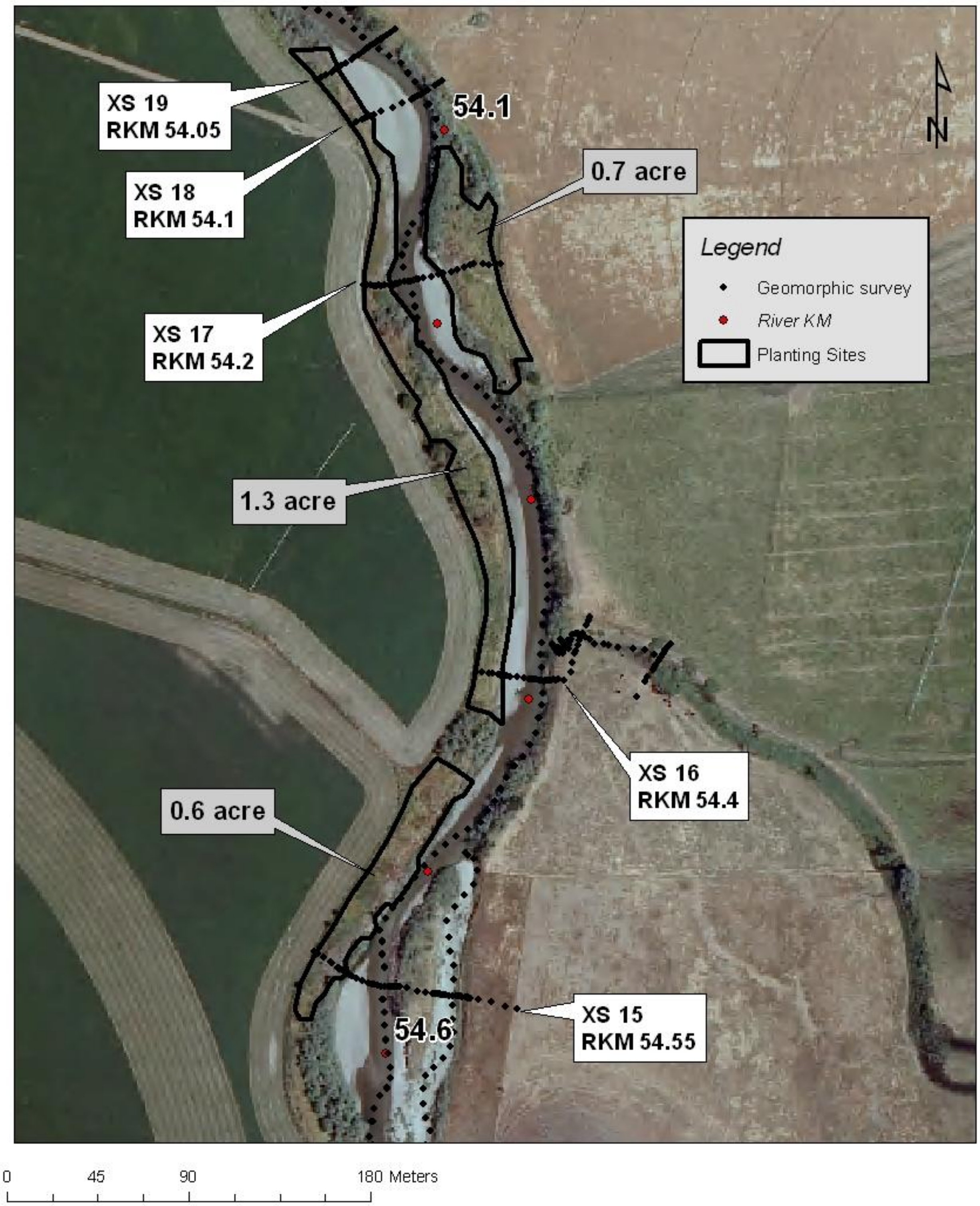
Map 7 – potential planting sites – RKM 55.7 – RKM 55.2

Potential Planting Sites - RKM 55.2 - 54.6

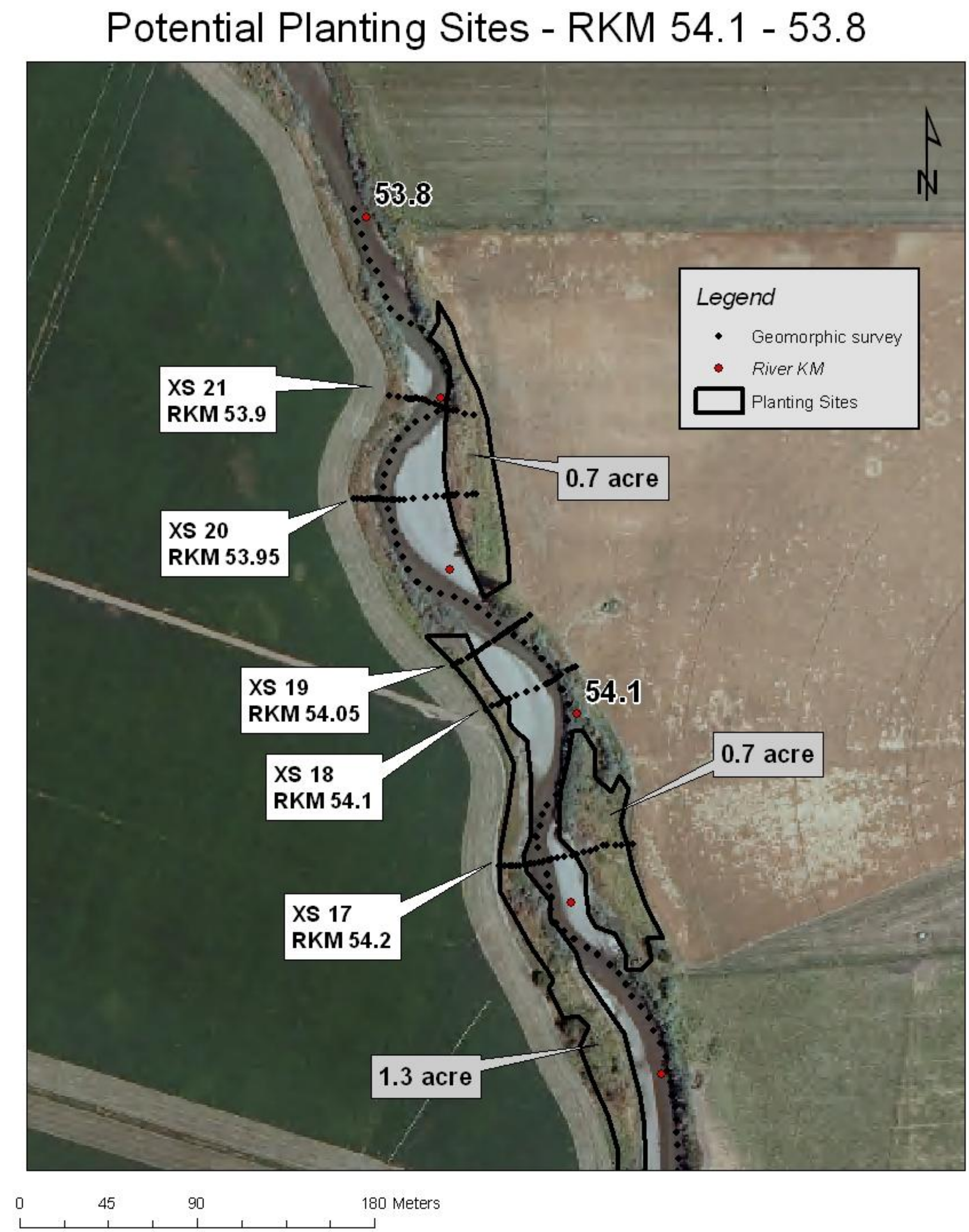


Map 8 – potential planting sites – RKM 55.2 – RKM 54.6

Potential Planting Sites - RKM 54.6 - 54.1



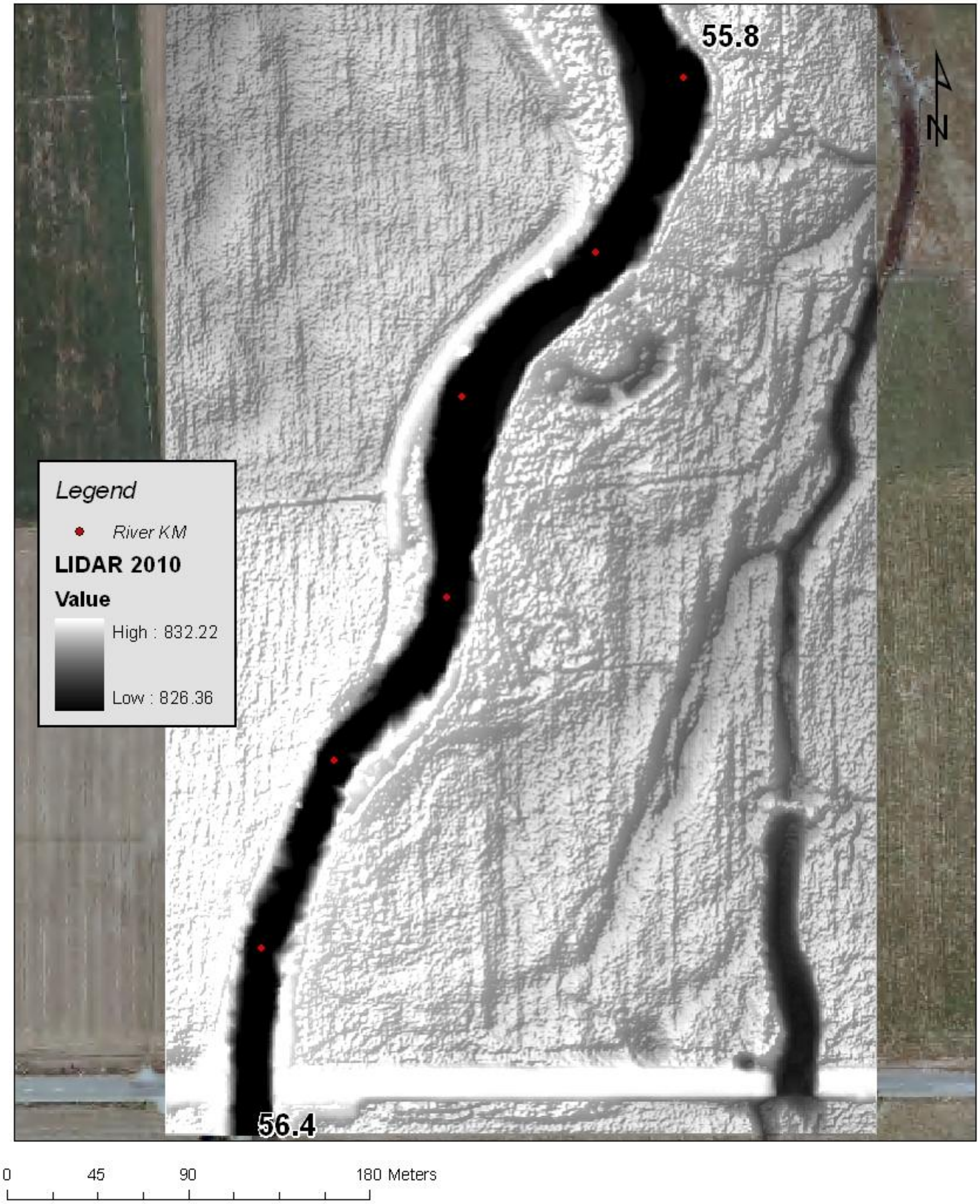
Map 9 – potential planting sites – RKM 54.6 – RKM 54.1



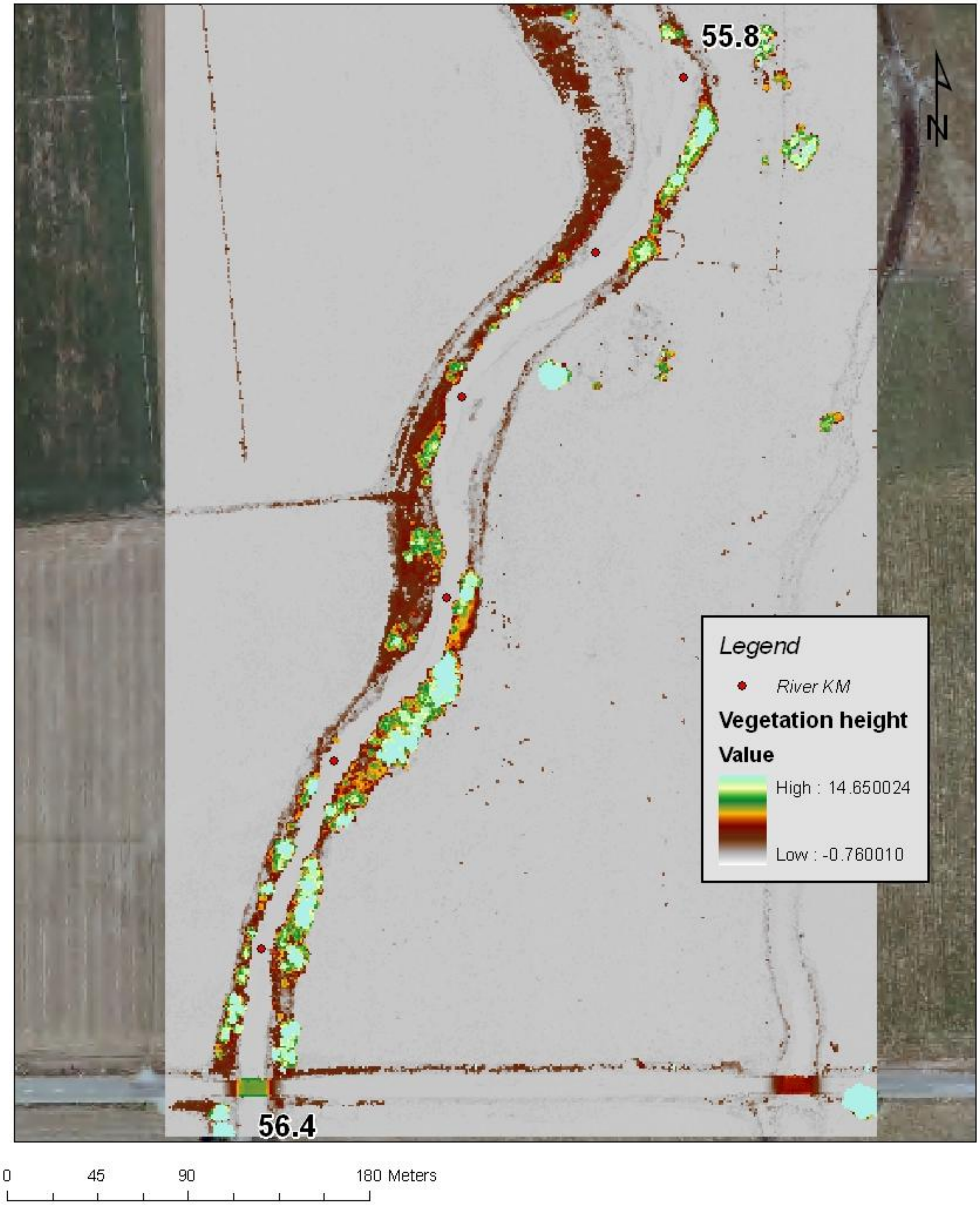
Map 10 – potential planting sites – RKM 54.1 – RKM 53.8

RKM 55.8 - 56.4 - NAIP 2010

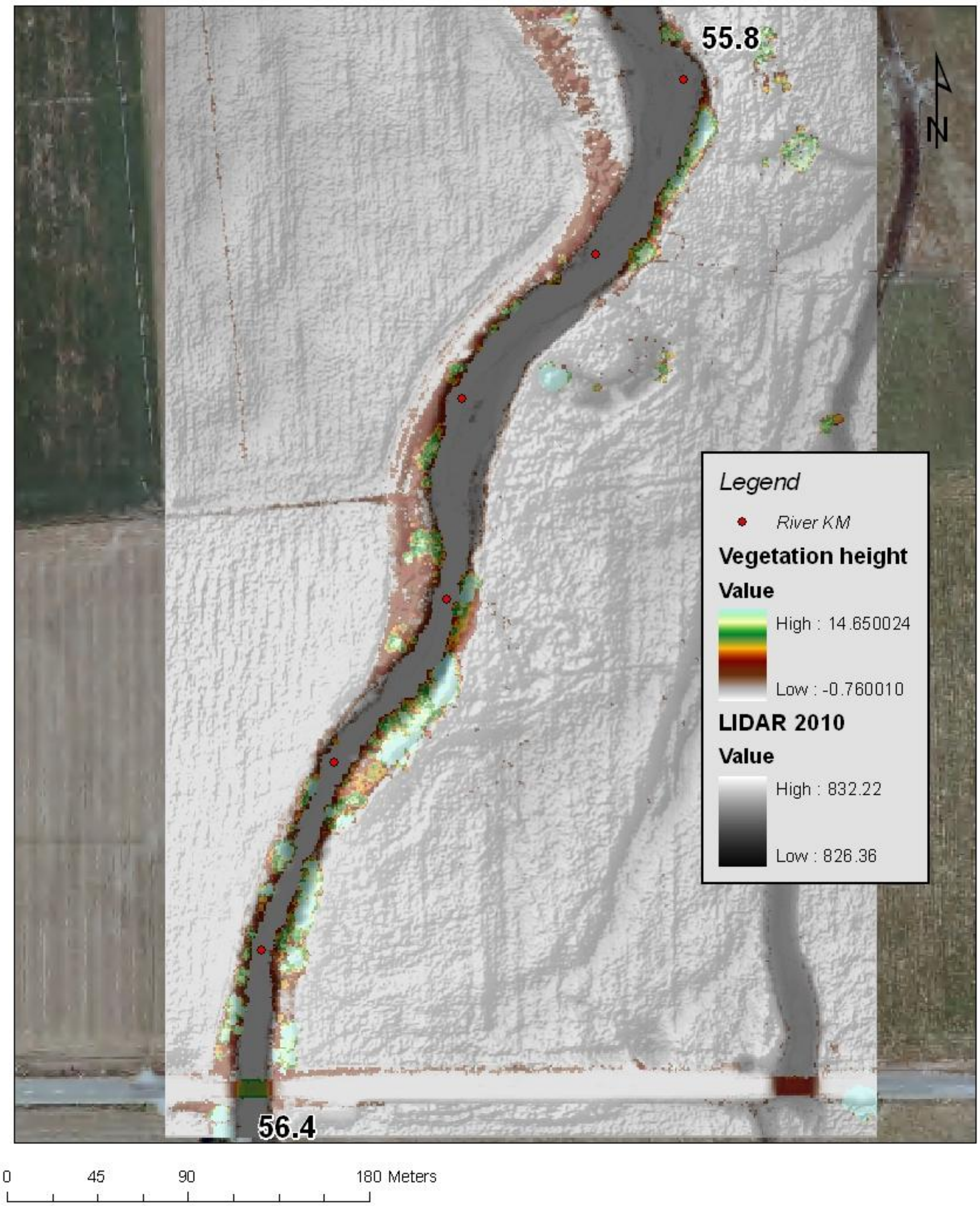
RKM 55.8 - 56.4 - LIDAR - Bare Earth



RKM 55.8 - 56.4 - LIDAR - Vegetation height

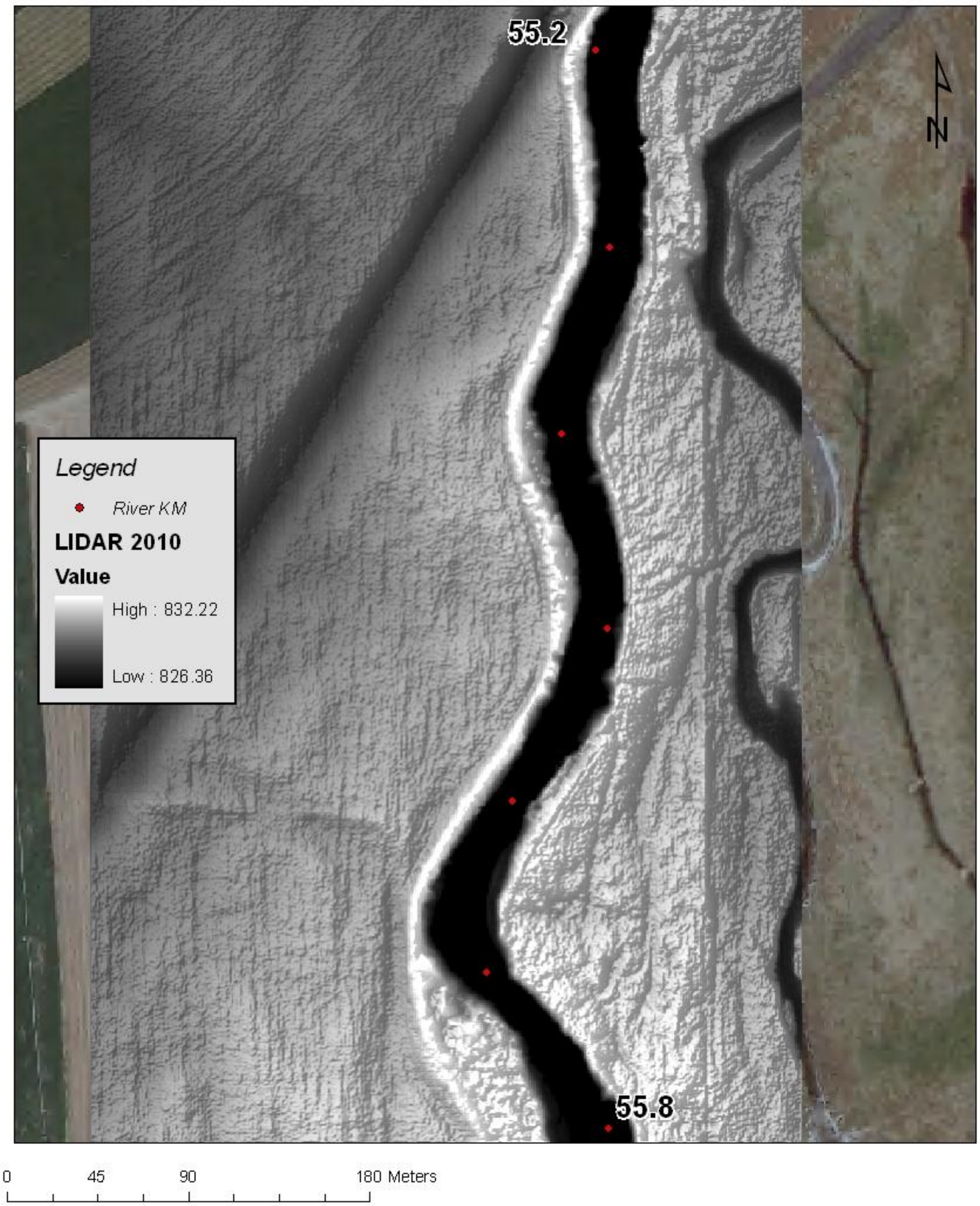


RKM 55.8 - 56.4 - LIDAR - Vegetation height

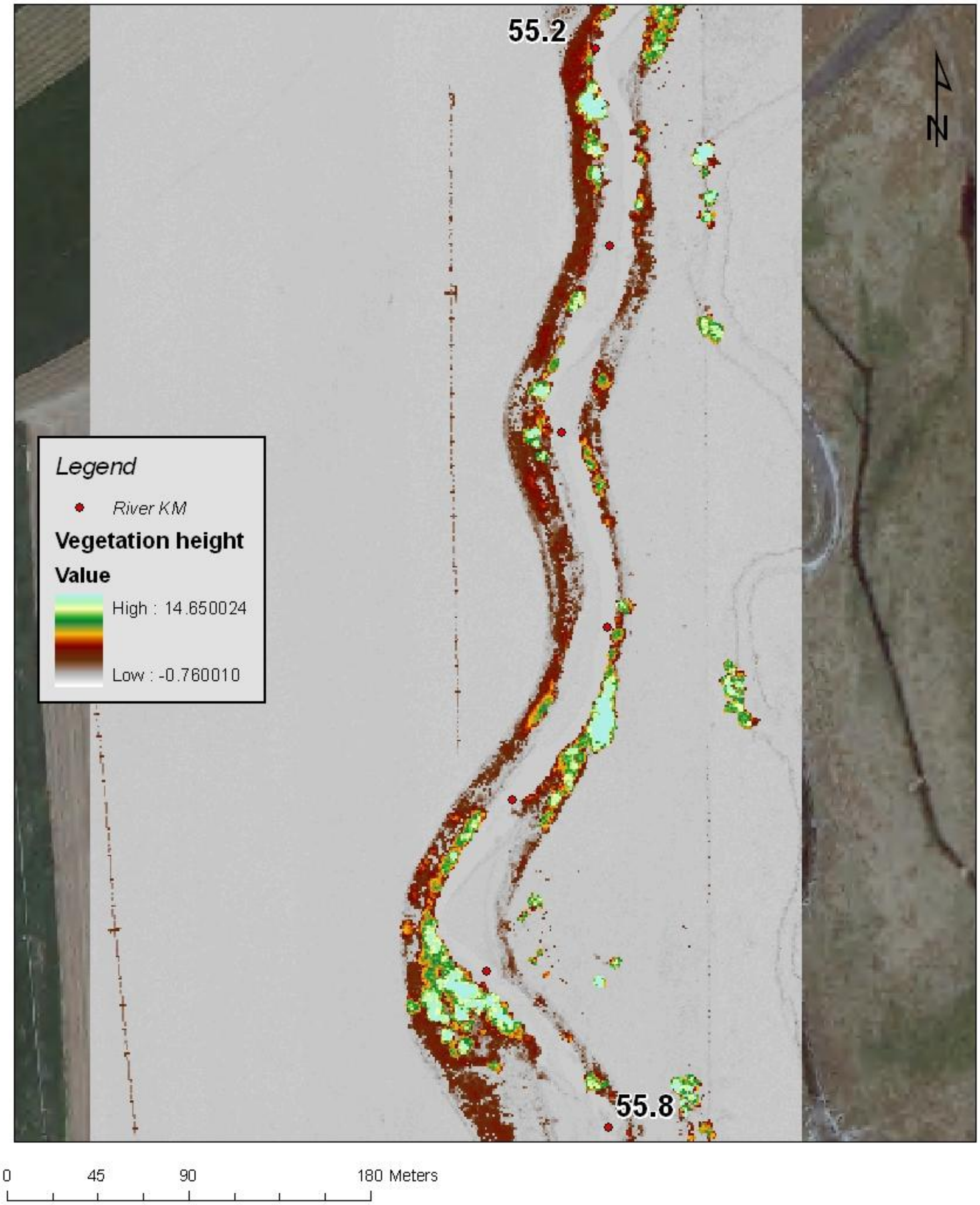


RKM 55.8 - 55.2 - NAIP 2010

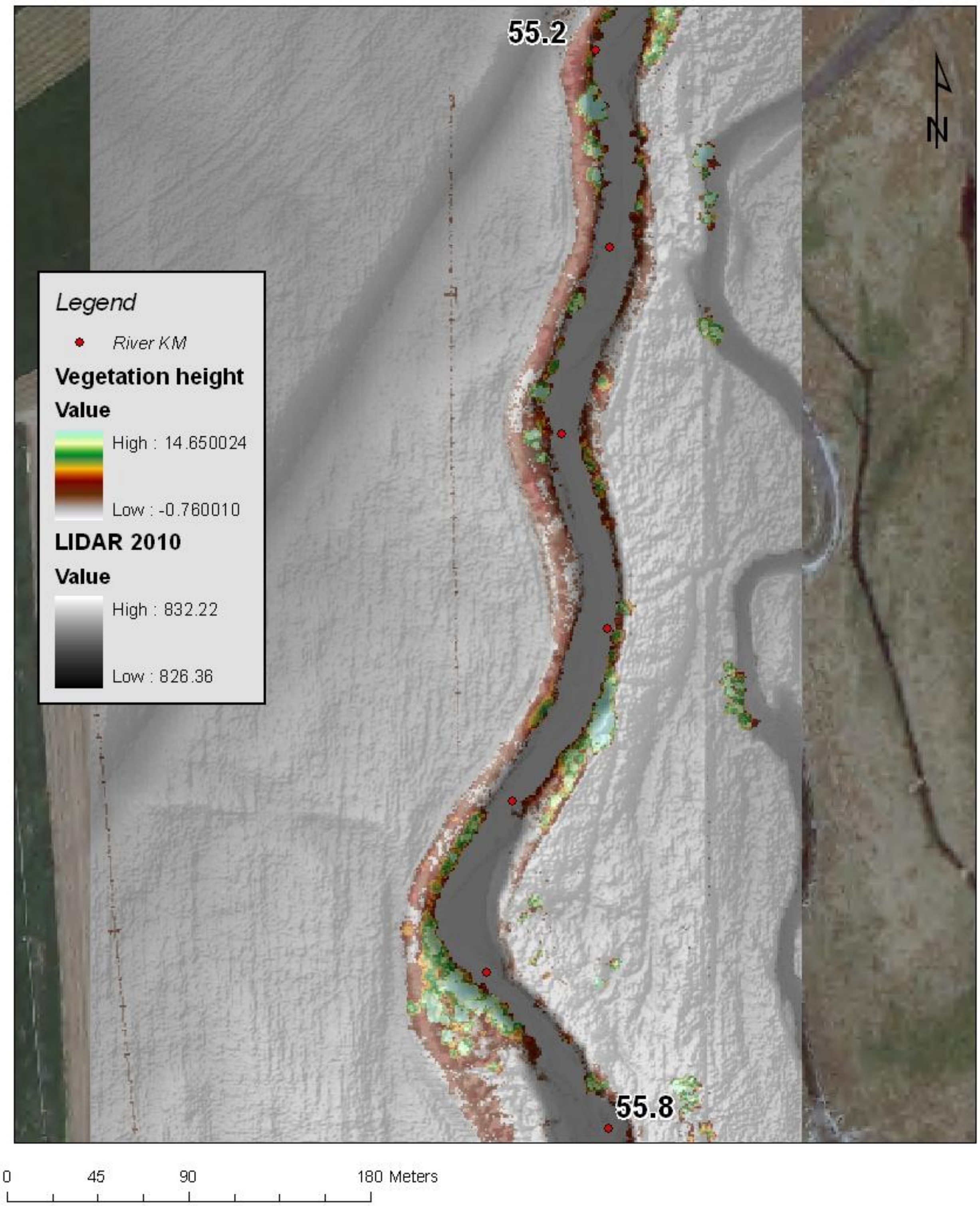
RKM 55.8 - 55.2 - LIDAR - Bare Earth



RKM 55.8 - 55.2 - LIDAR - Vegetation Height



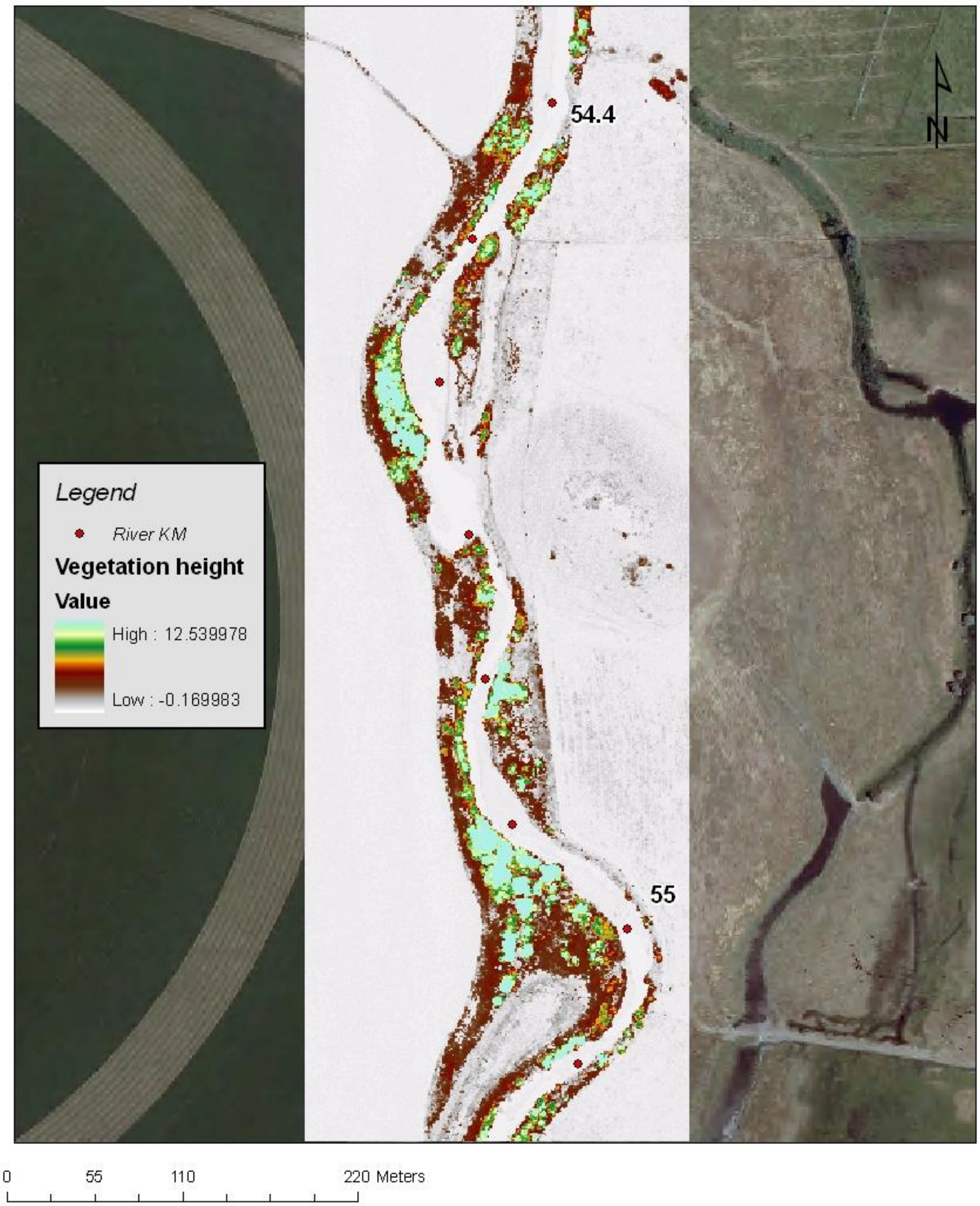
RKM 55.8 - 55.2 - LIDAR - Vegetation Height



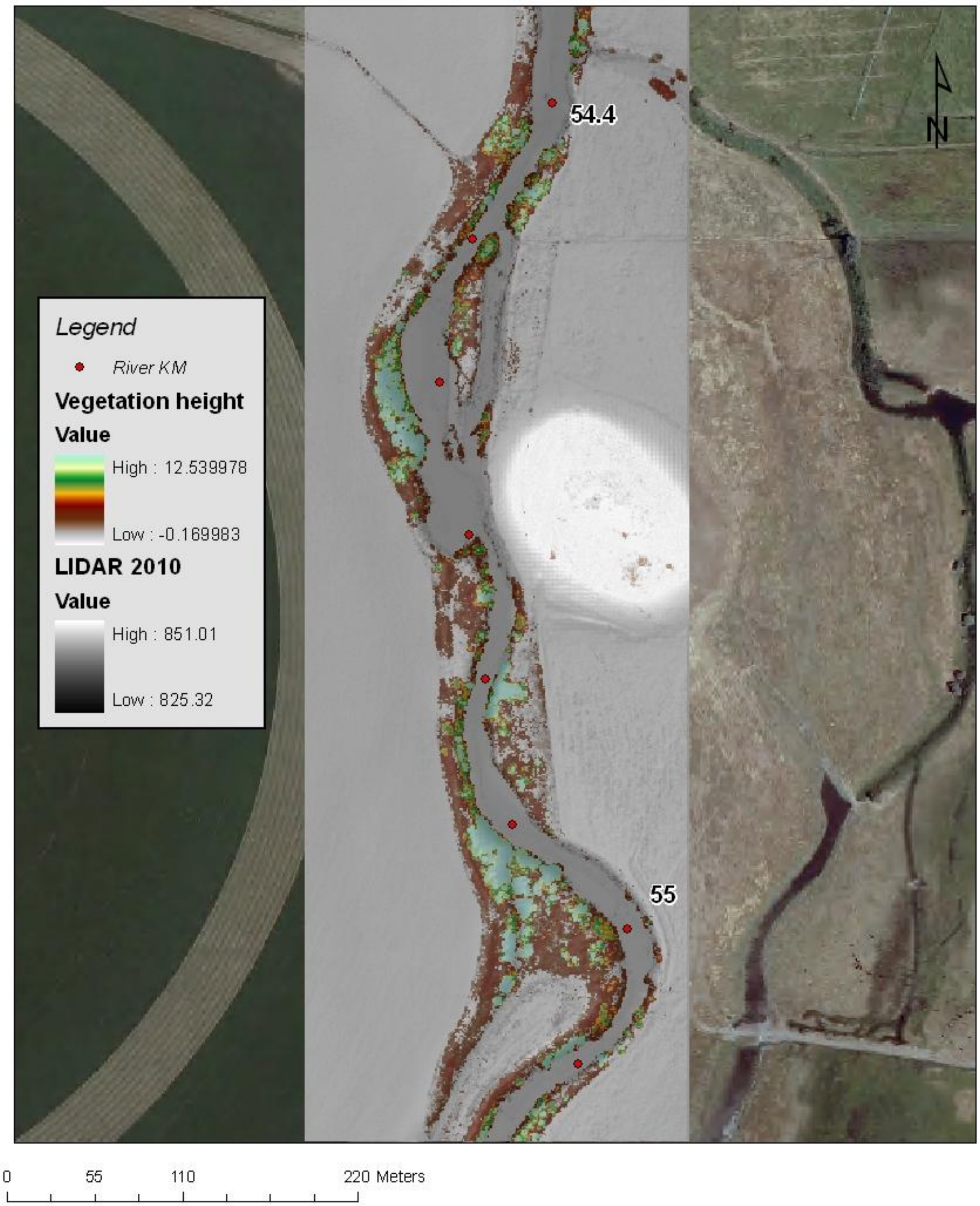
RKM 55.1 - 54.4 - NAIP 2010

RKM 55.1 - 54.4 - LIDAR - Bare Earth

RKM 55.1 - 54.4 - LIDAR - Vegetation Height

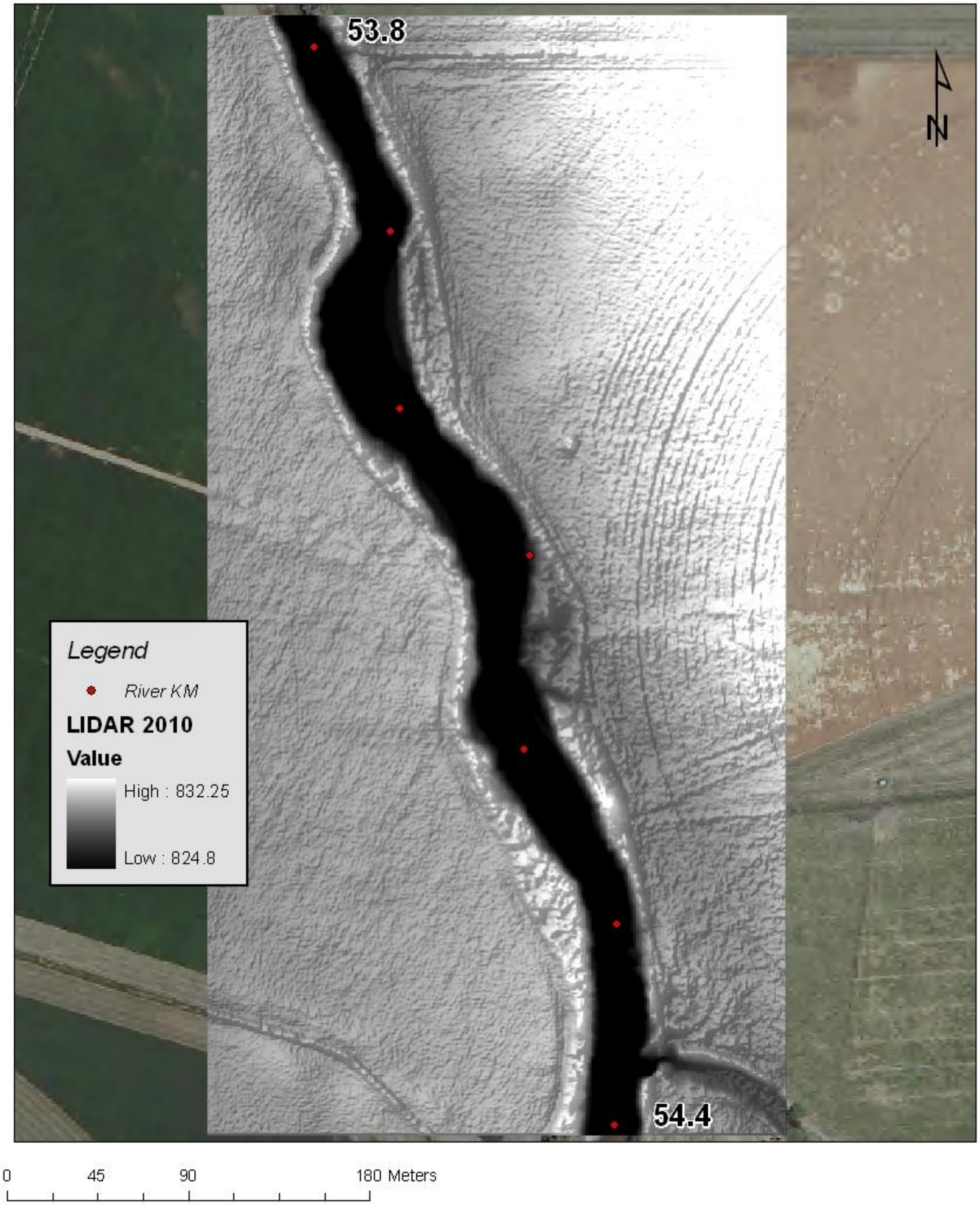


RKM 55.1 - 54.4 - LIDAR - Vegetation Height

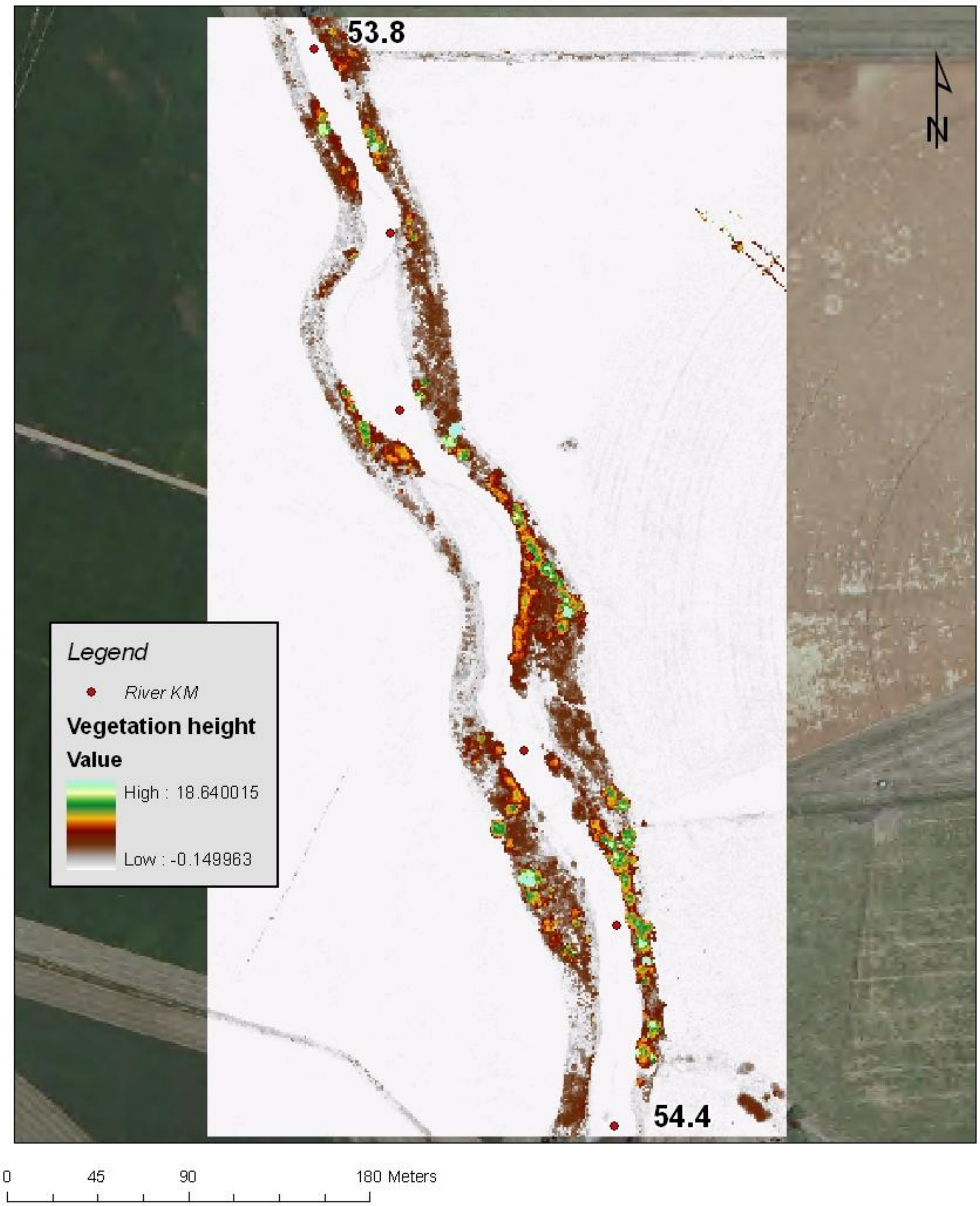


RKM 54.4 - 53.8 - NAIP 2010

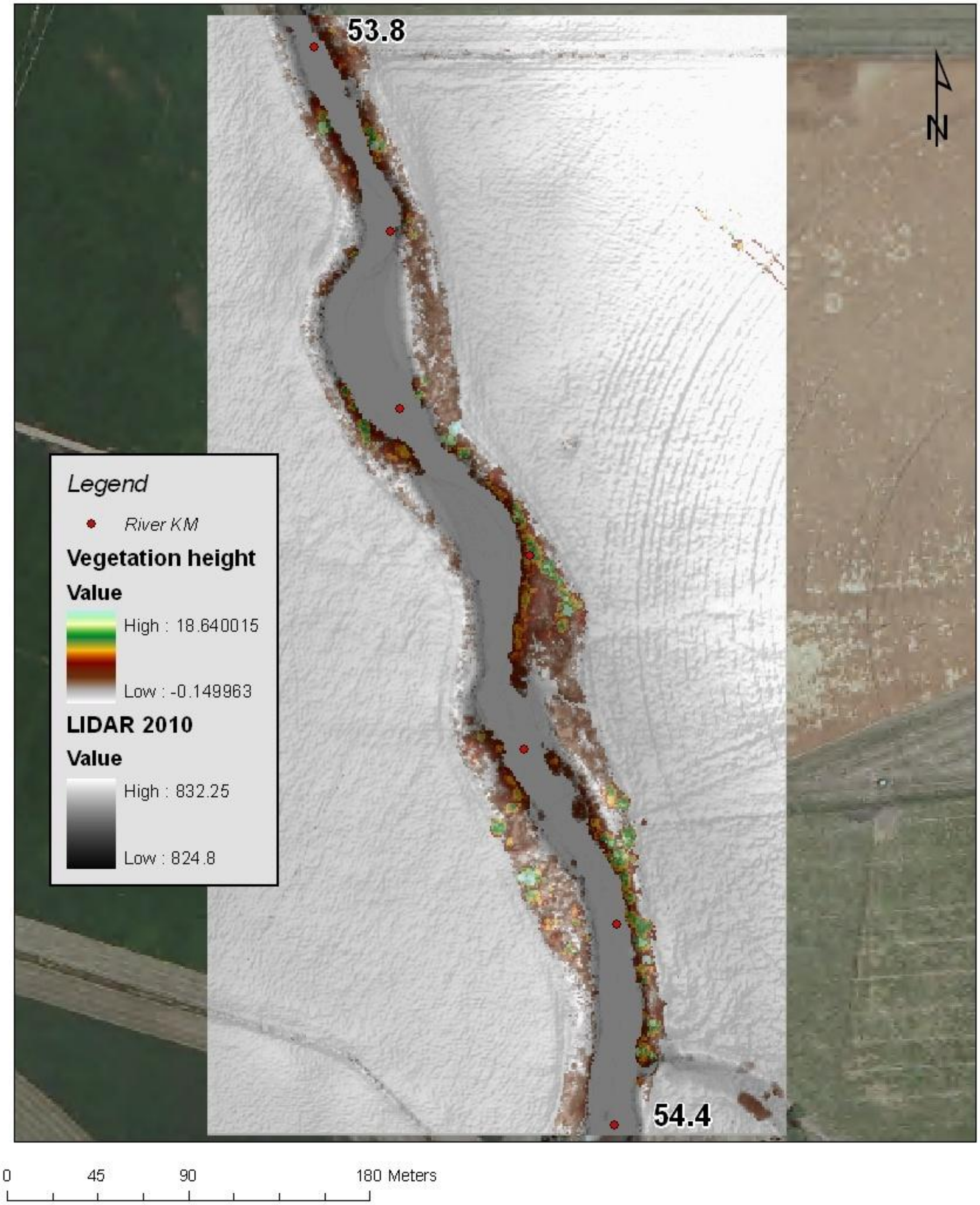
RKM 54.4 - 53.8 - LIDAR - Bare Earth



RKM 54.4 - 53.8 - LIDAR - Vegetation Height

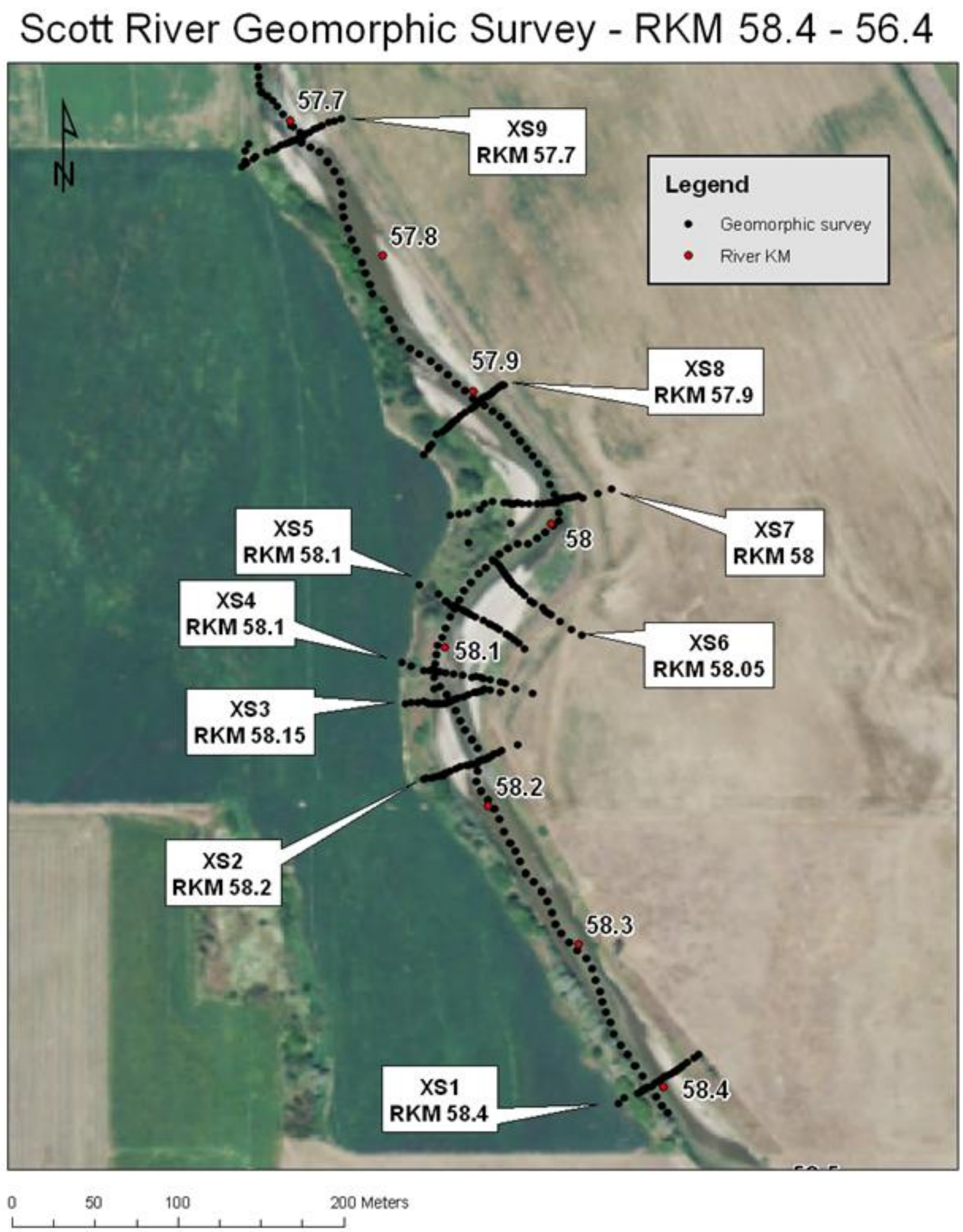


RKM 54.4 - 53.8 - LIDAR - Vegetation Height



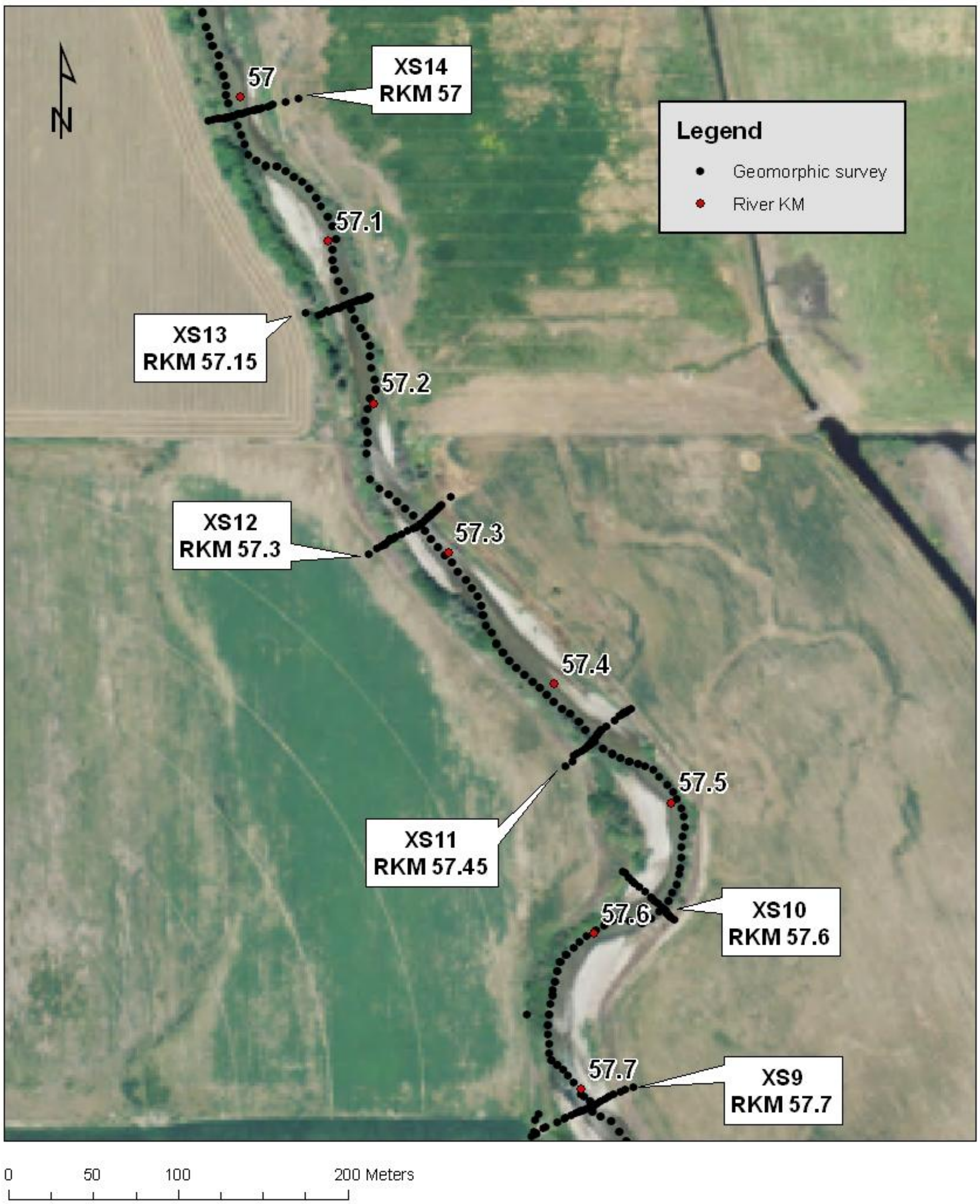
RKM 58.4 – RKM 56.4 – Hanna Ranch

Stream Channel cross section data and longitudinal profiles were collected by the Siskiyou RCD in the summer of 2010.



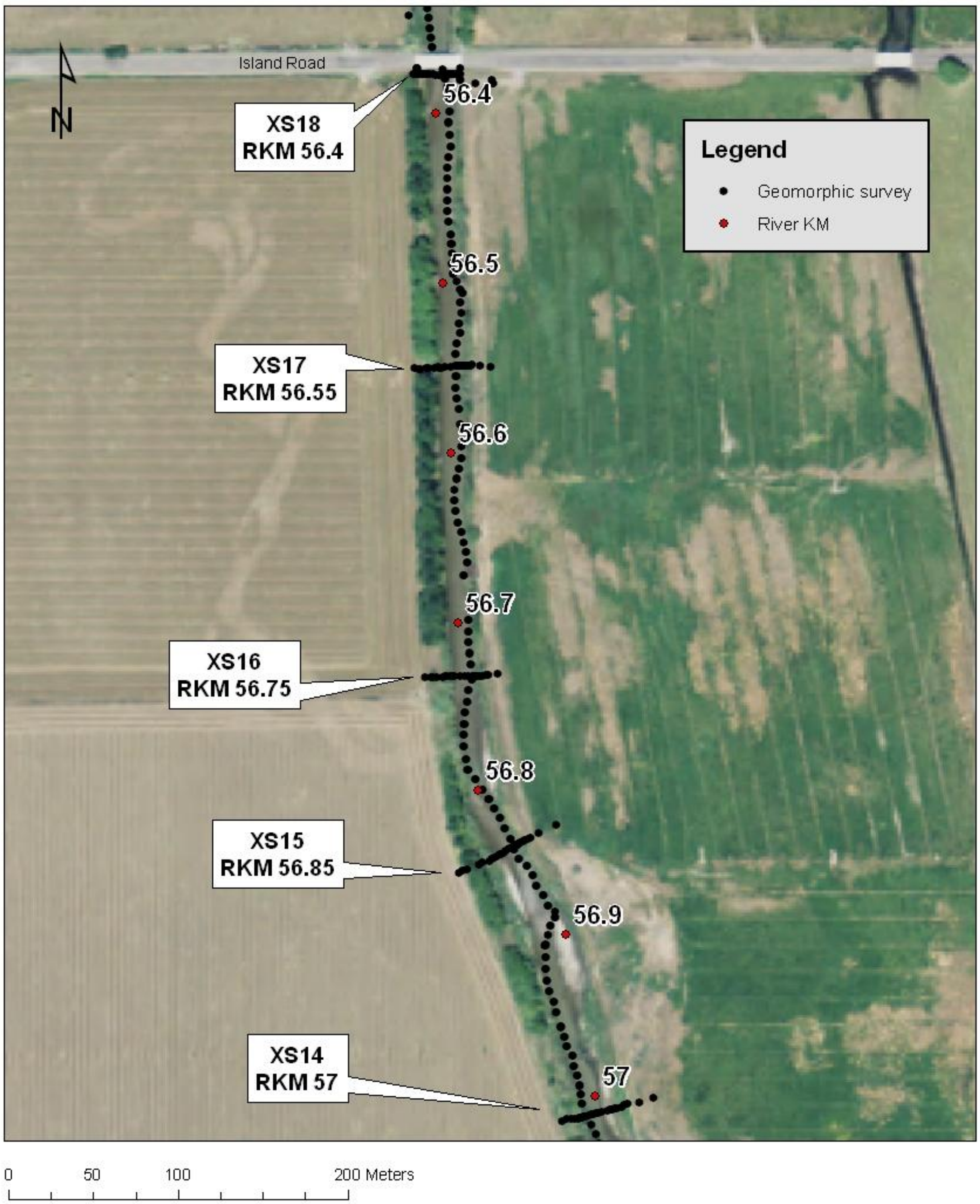
Map 1 – up stream portion of surveyed reach – RKM 58.4 – RKM 56.4

Scott River Geomorphic Survey - RKM 58.4 - 56.4

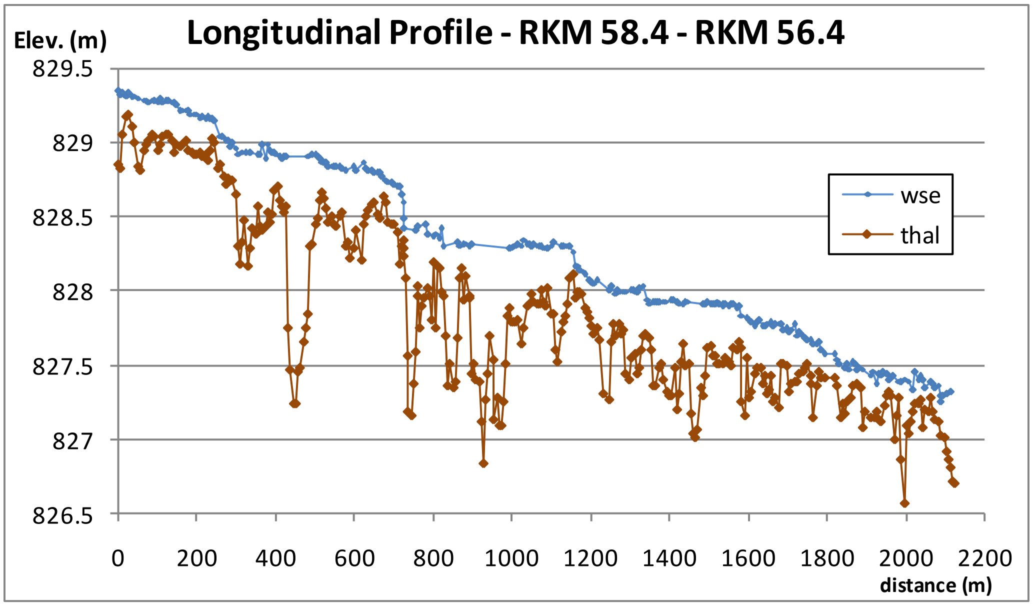


Map 2 – middle portion of surveyed reach – RKM 58.4 – 56.4

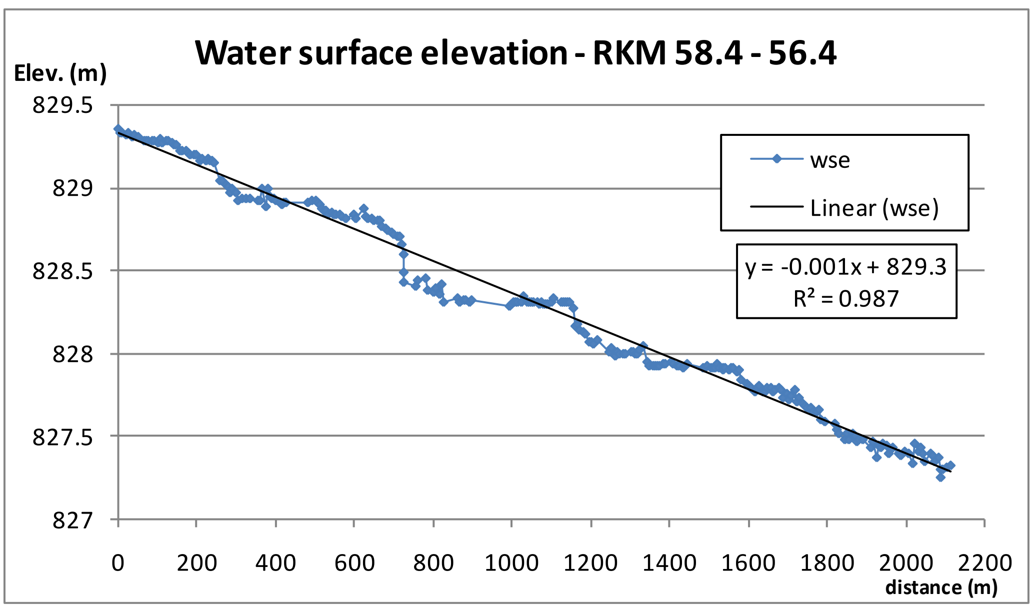
Scott River Geomorphic Survey - RKM 58.4 - 56.4



Map 3 – downstream portion of surveyed reach – RKM 58.4 – 56.4



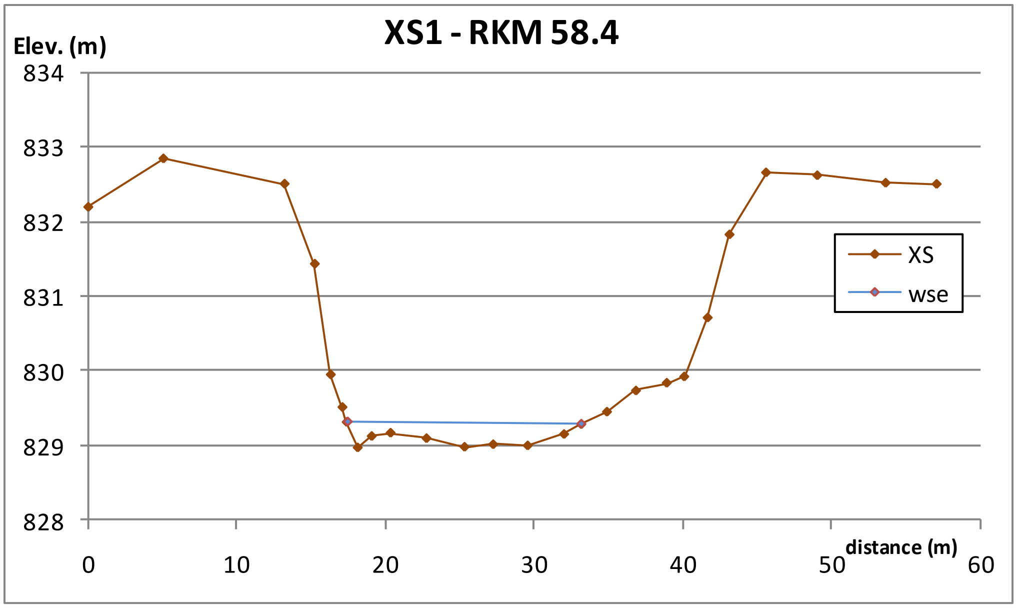
Graph 1 – Longitudinal profile and water surface elevation – RKM 58.4 – RKM 56.4



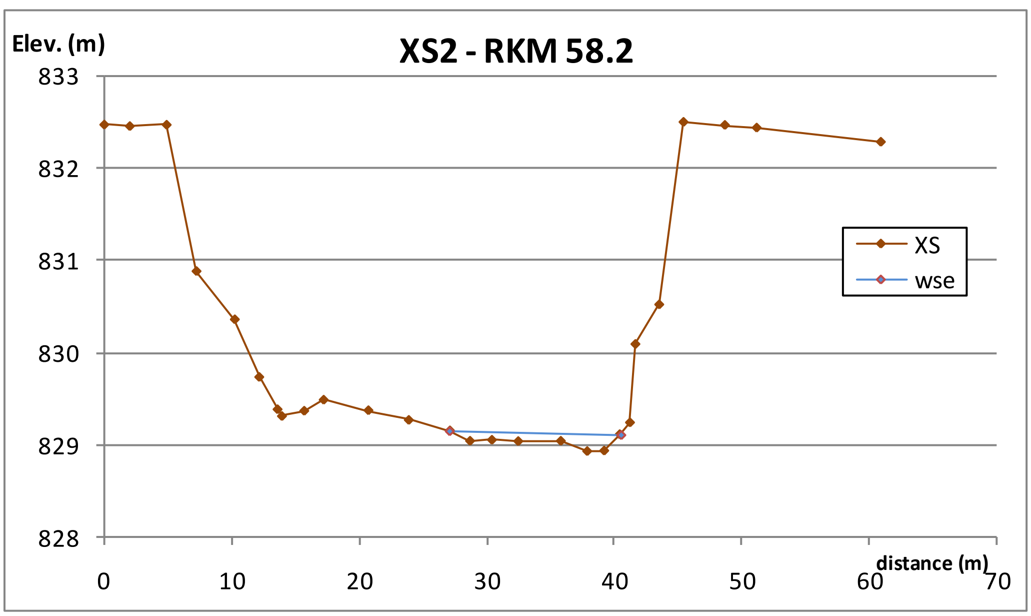
Graph 2 – Water surface elevation and stream gradient – RKM 58.4 – RKM 56.4

Stream KM	Potential Shade	Current Shade	Potential Shade Increase
58.4	0.38	0.3	0.08
58.3	0.53	0.33	0.2
58.2	0.38	0.29	0.09
58.1	0.37	0.01	0.36
58	0.27	0.07	0.2
57.9	0.17	0.09	0.08
57.8	0.37	0.3	0.07
57.7	0.29	0.02	0.27
57.6	0.28	0.21	0.07
57.5	0.38	0.09	0.29
57.4	0.27	0.02	0.25
57.3	0.37	0.28	0.09
57.2	0.49	0.1	0.39
57.1	0.39	0.31	0.08
57	0.5	0.02	0.48
56.9	0.38	0.09	0.29
56.8	0.5	0.31	0.19
56.7	0.5	0.42	0.08
56.6	0.62	0.31	0.31
56.5	0.62	0.33	0.29
56.4	0.51	0.32	0.19

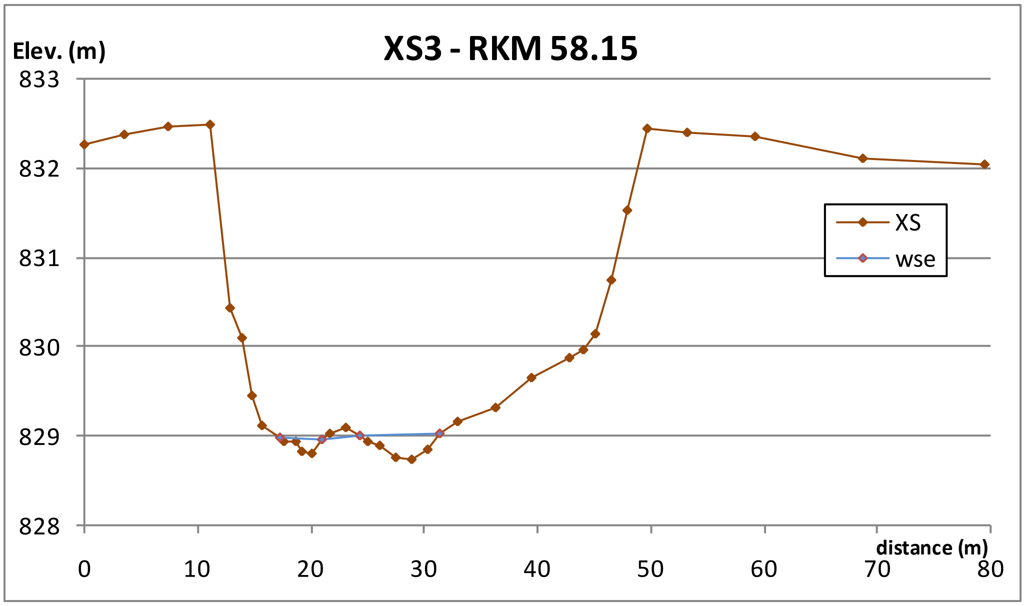
Table 1 – Potential and current shade from NCRWQCB Staff Report for Scott River TMDL



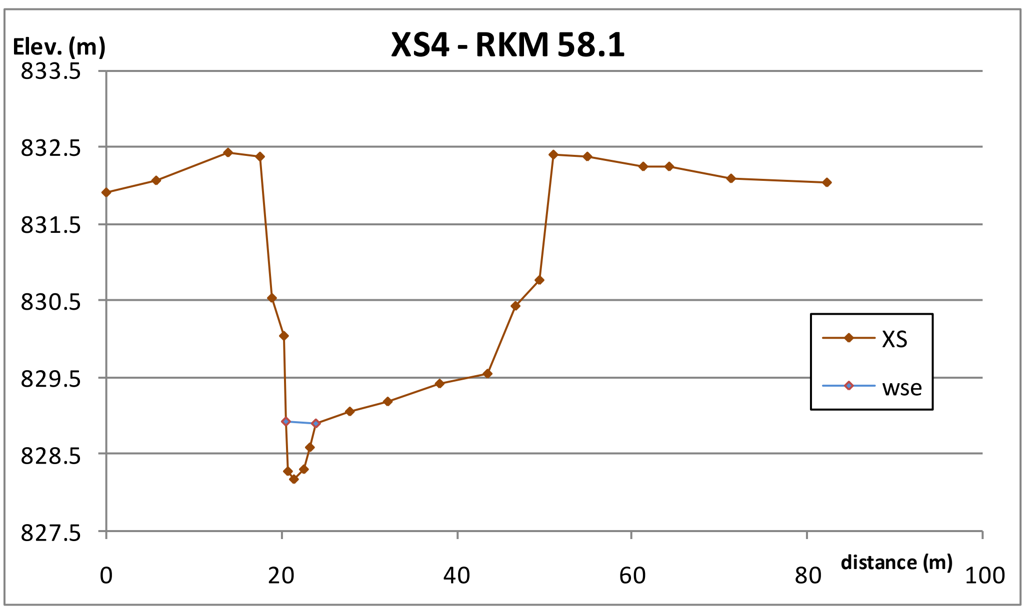
Graph 3 – XS1 at RKM 58.4



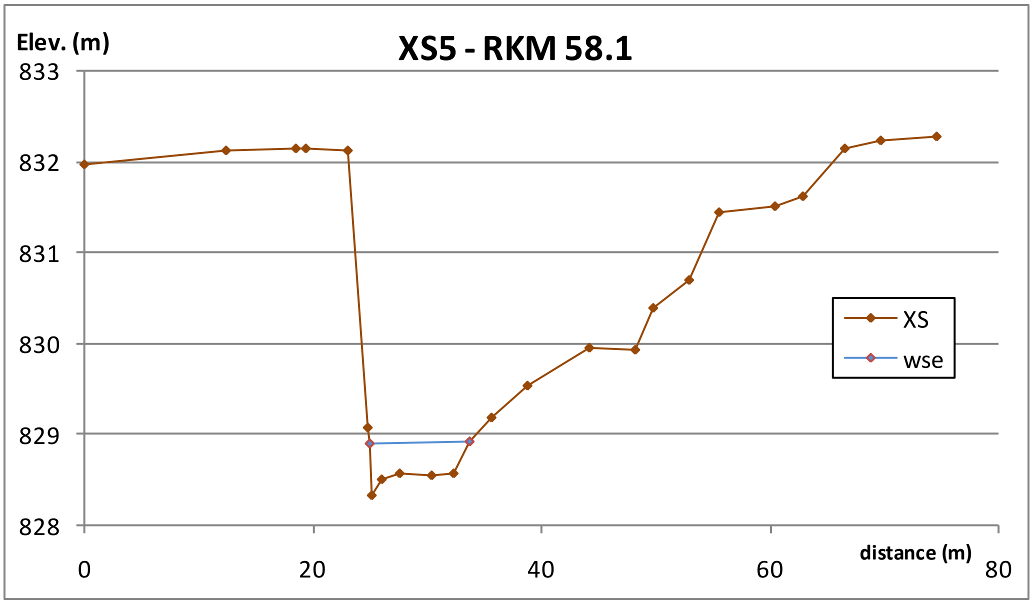
Graph 4 – XS2 at RKM 58.2



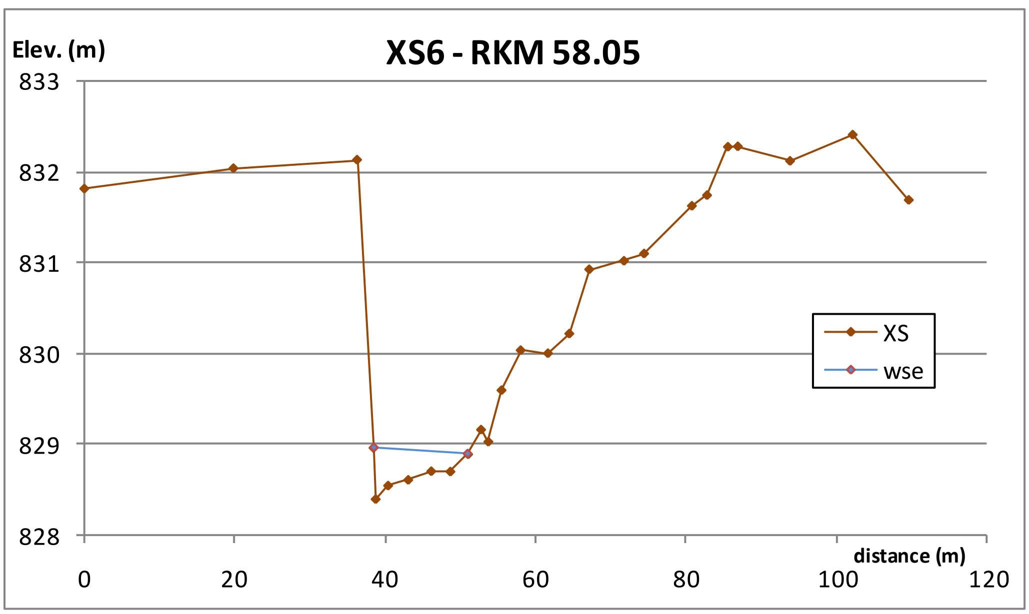
Graph 5 – XS3 at RKM 58.15



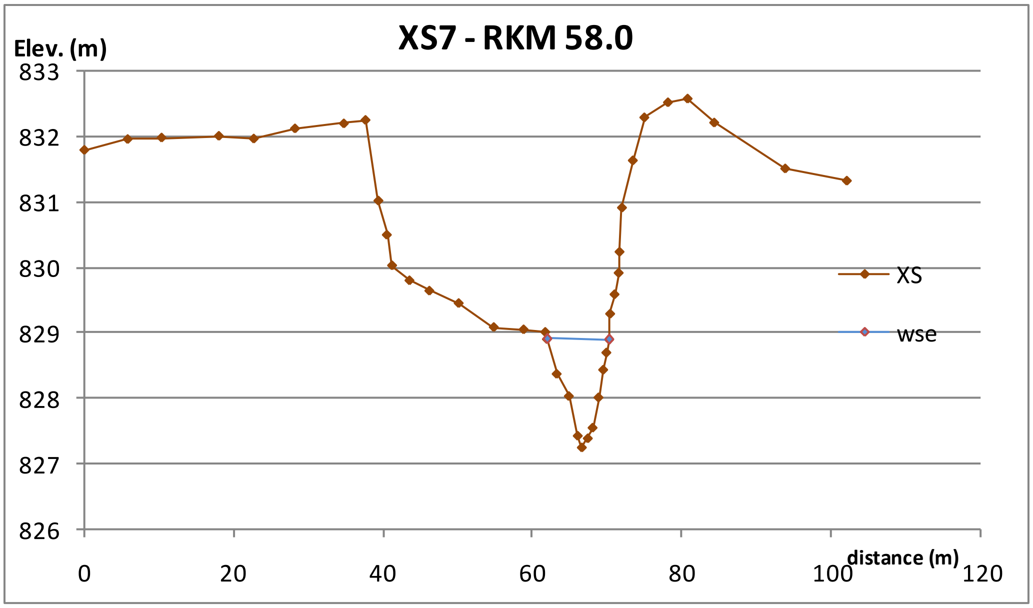
Graph 6 – XS4 at RKM 58.1



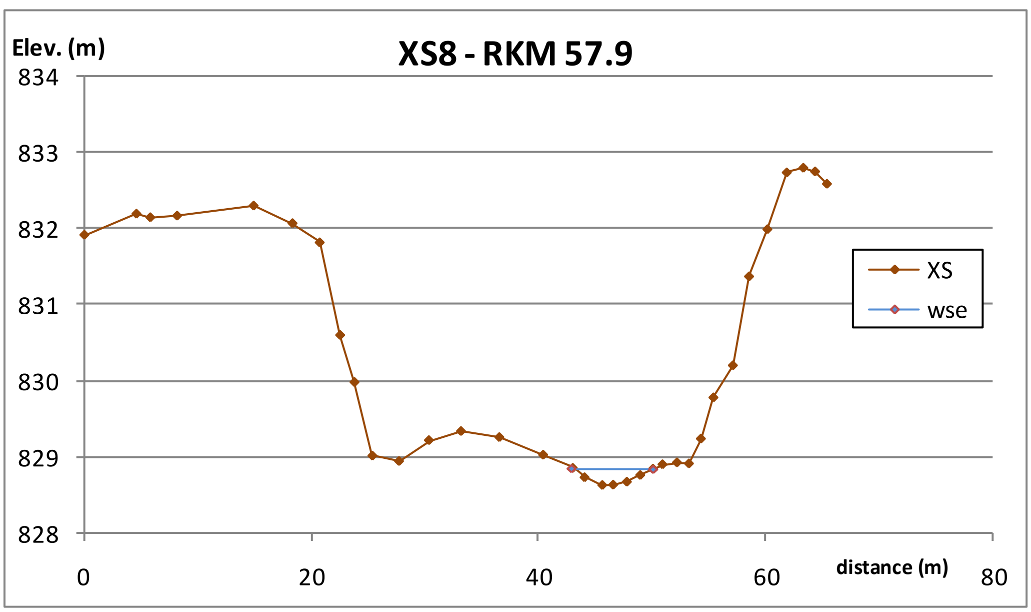
Graph 7 – XS5 at RKM 58.1



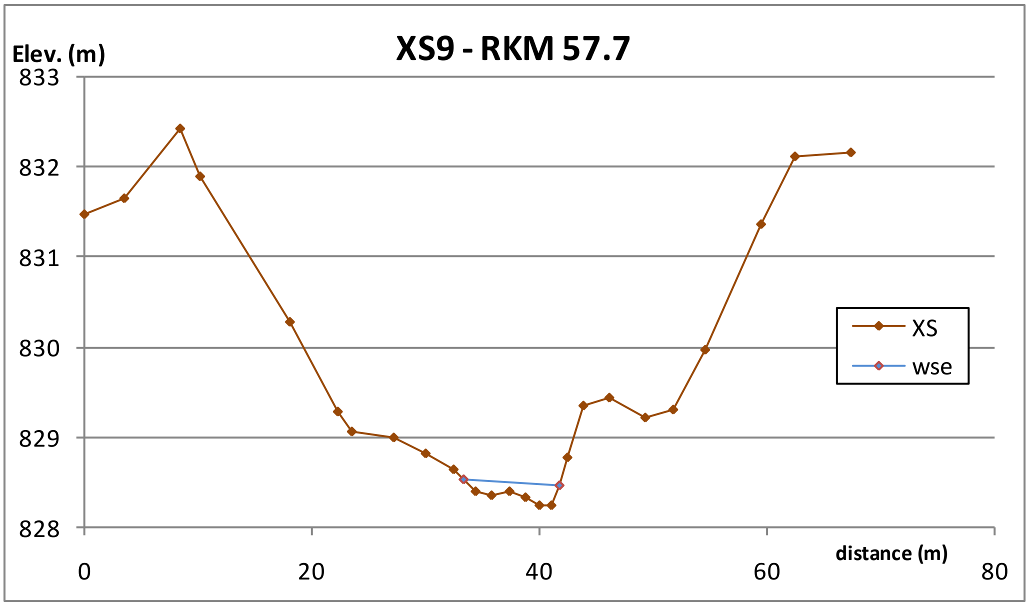
Graph 8 – XS6 at RKM 58.05



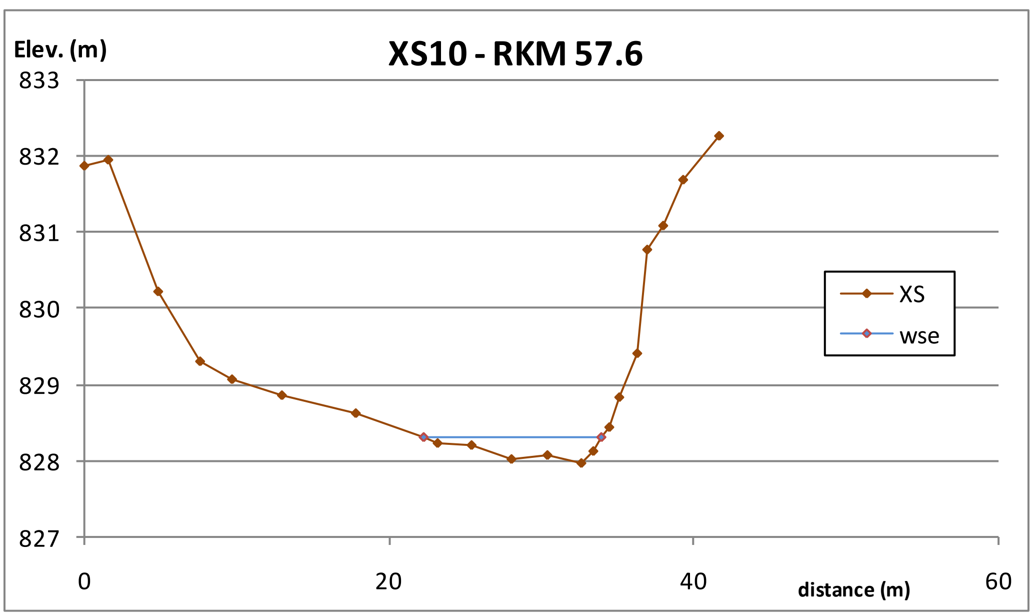
Graph 9 – XS7 at RKM 58.0



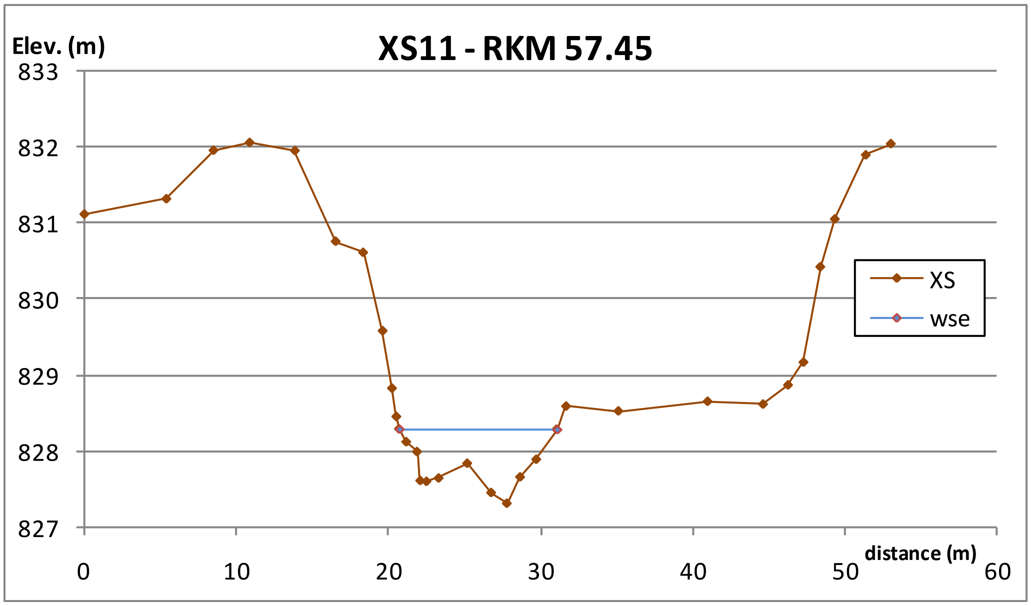
Graph 10 – XS8 at RKM 57.9



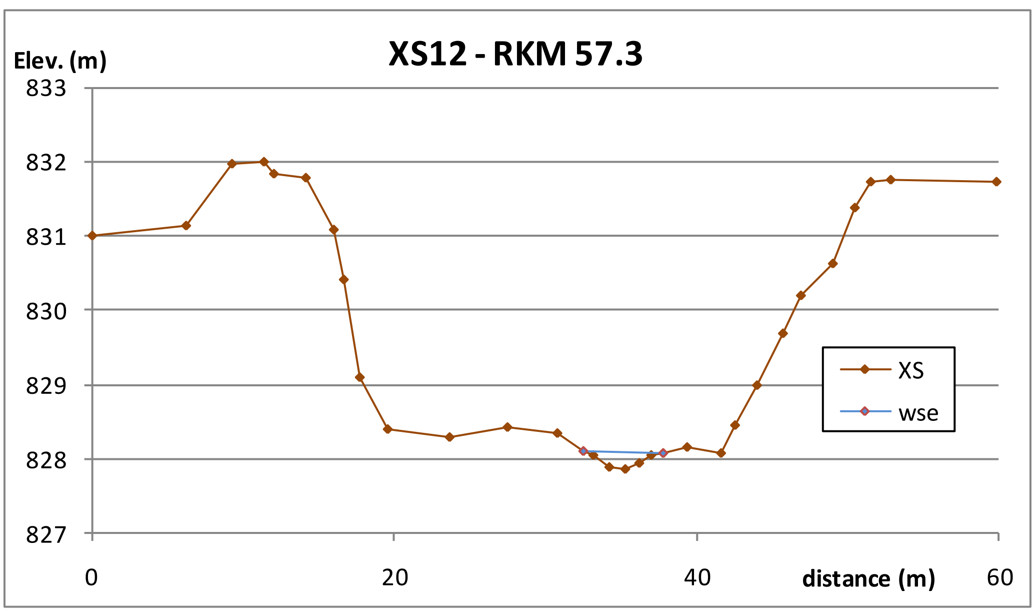
Graph 11 – XS9 at RKM 57.7



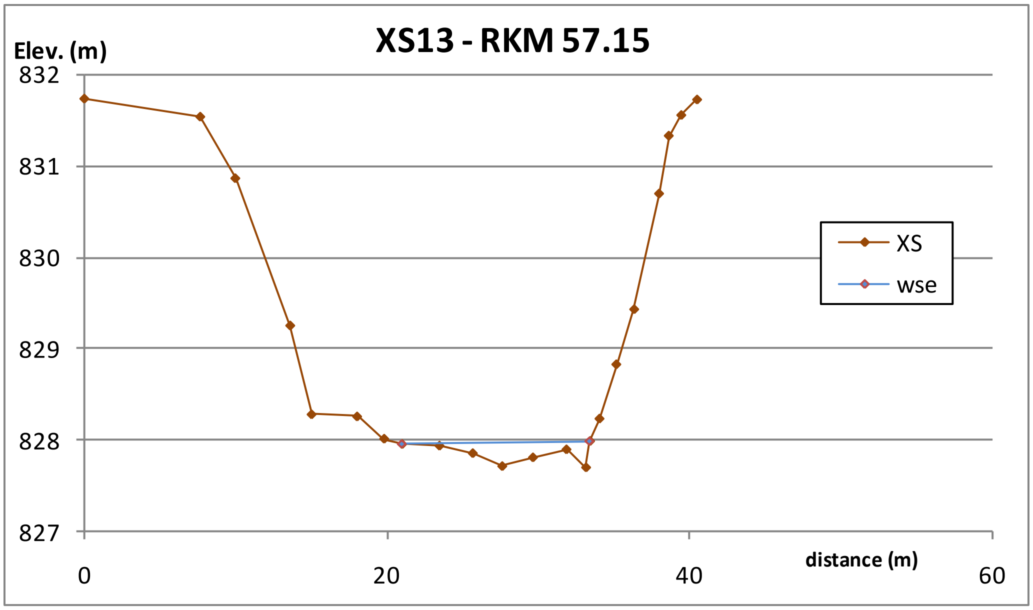
Graph 12 – XS10 at RKM 57.6



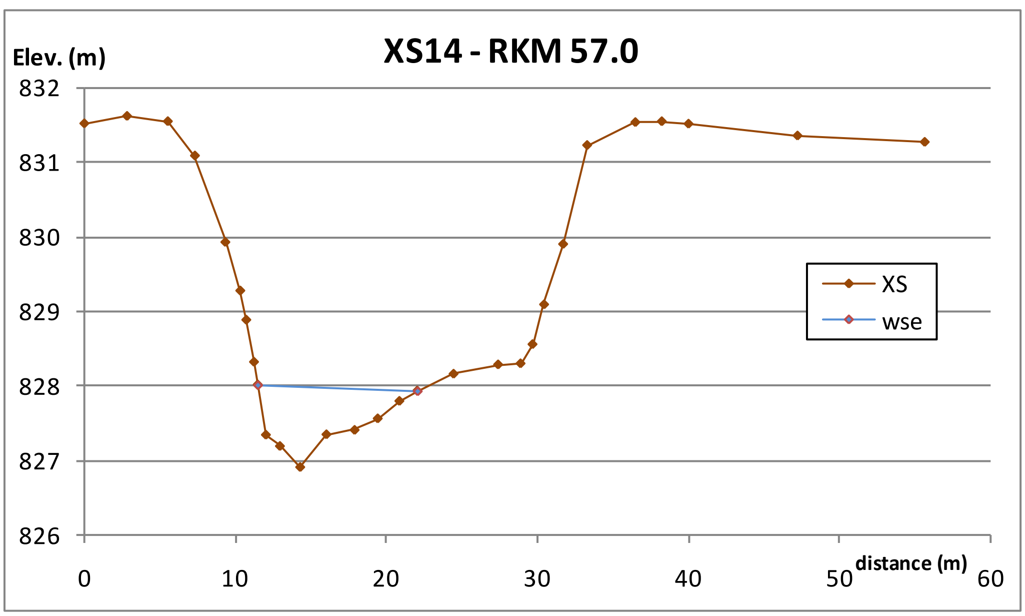
Graph 13 – XS11 at RKM 57.45



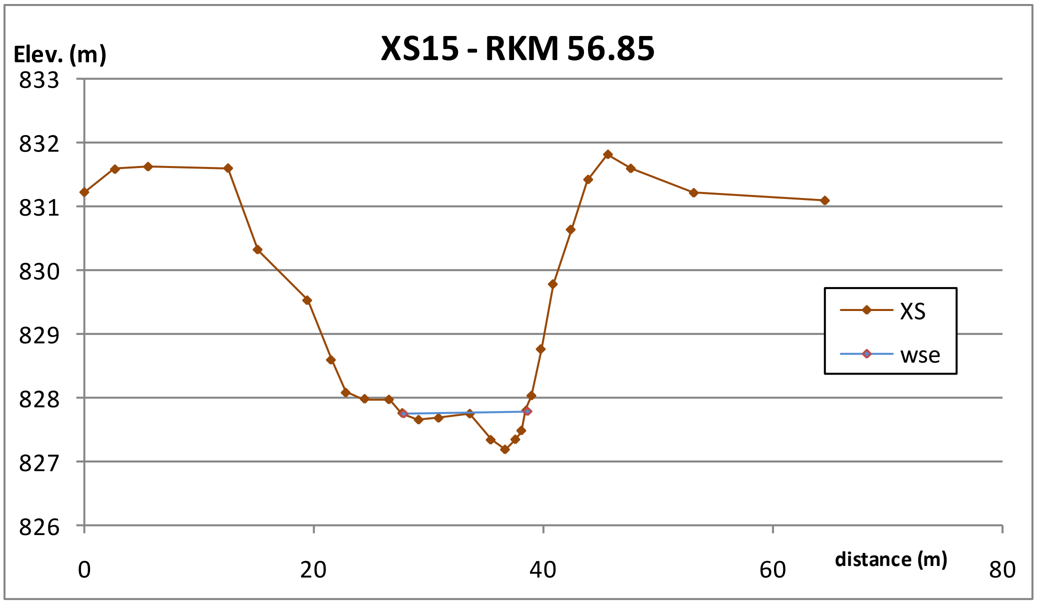
Graph 14 – XS12 at RKM 57.3



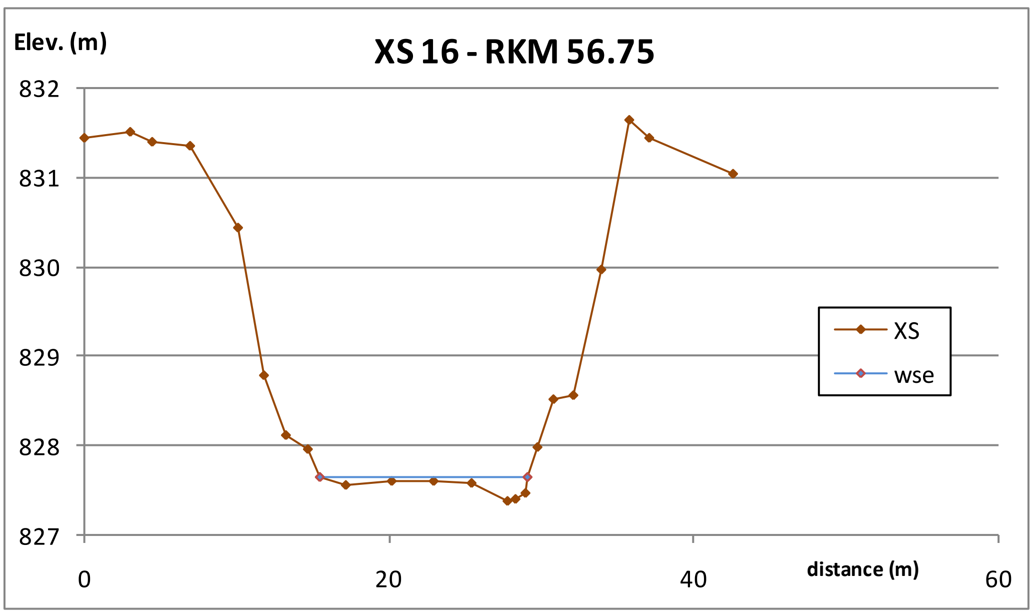
Graph 15 – XS13 at RKM 57.15



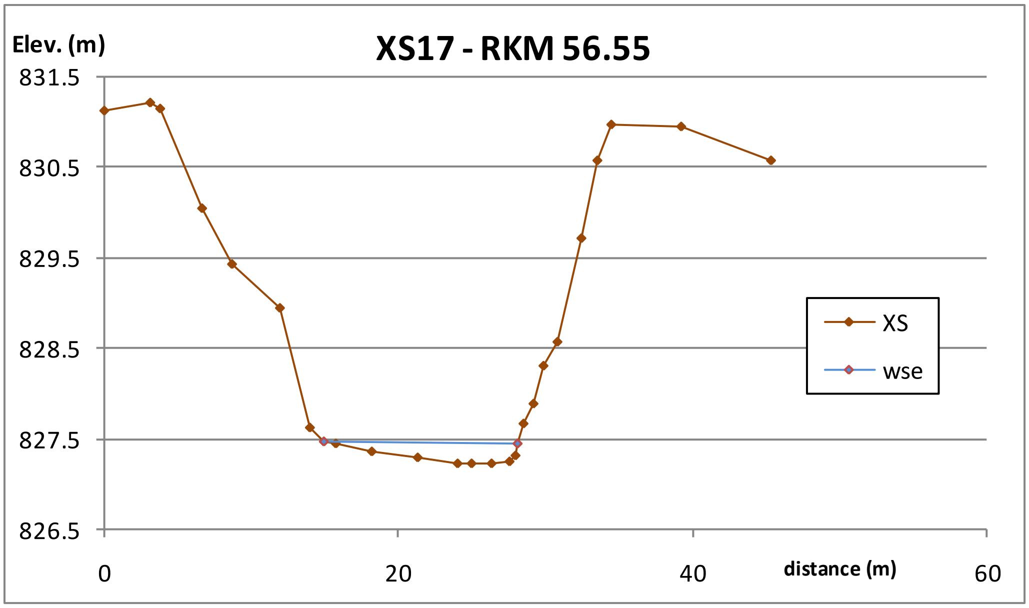
Graph 16 – XS14 at RKM 57.0



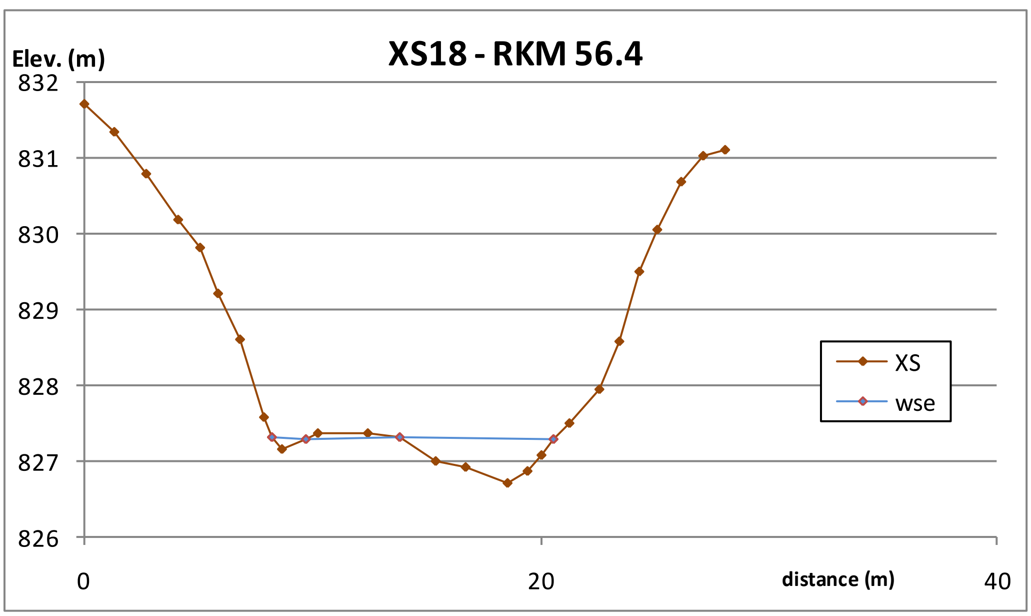
Graph 17 – XS15 at RKM 56.85



Graph 18 – XS16 at RKM 56.75



Graph 19 – XS17 at RKM 56.55



Graph 20 – XS18 at RKM 56.4

Bank Height and Channel Width Calculations

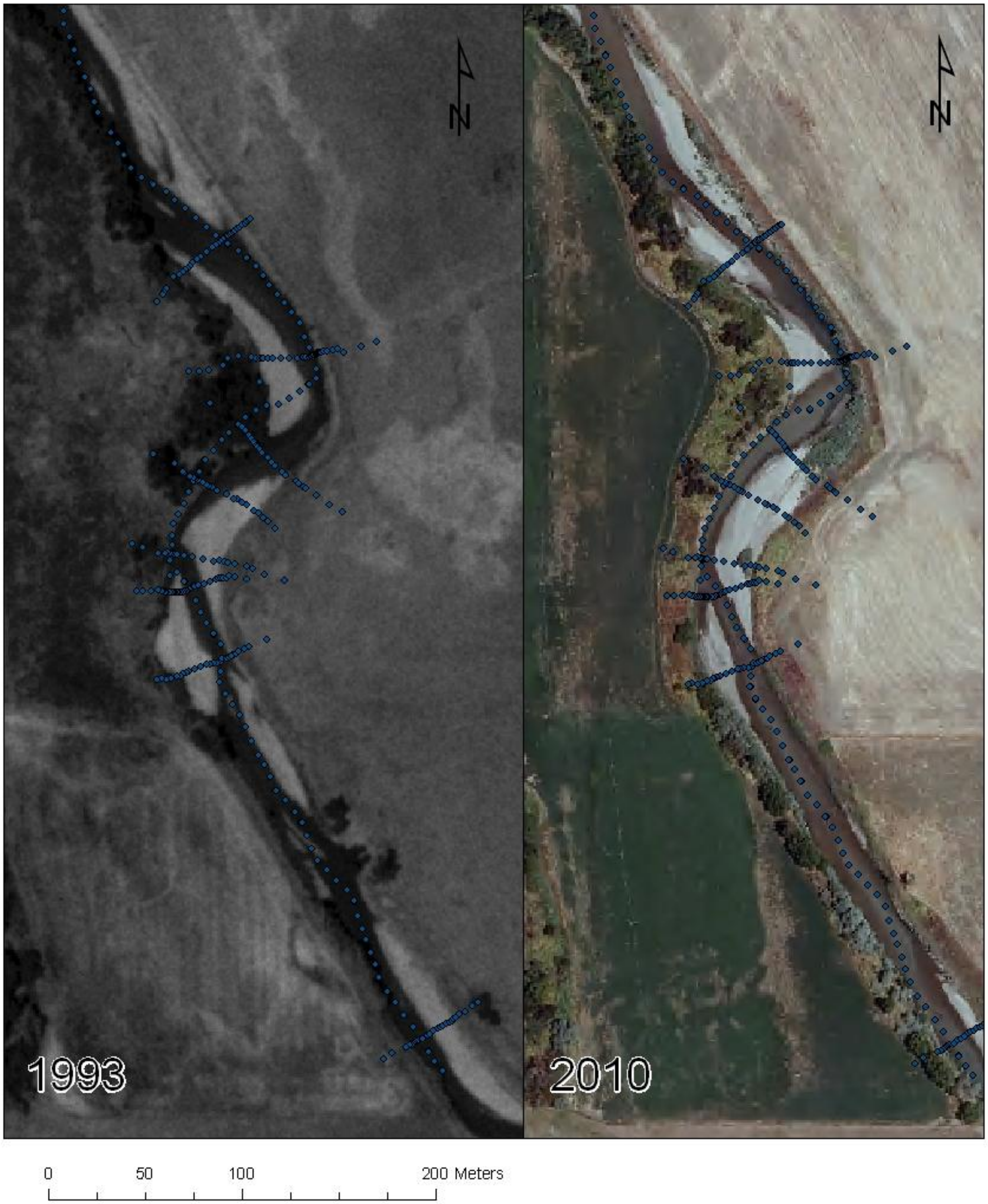
The distance from the river's thalweg to the top of the right and left bank was calculated for each cross section (Table 2). Both banks have approximately 4.0 meter (13 ft) rise from thalweg to top.

There is one vertical cut bank at the upstream portion of the survey on river left (XS4 – XS6). The thalweg of the Scott River is adjacent to the toe of the cut bank that is approximately 375 ft long and 13 feet high. Comparison of aerial images from 1993 and 2010 indicate that the lateral bank migration has progressed approximately 10 meters at the maximum over the 17 year period (Map 4). Besides this lateral bank migration the reach is relatively stable during the period covered by the imagery.

Table 2 – bank height and channel width (meters)

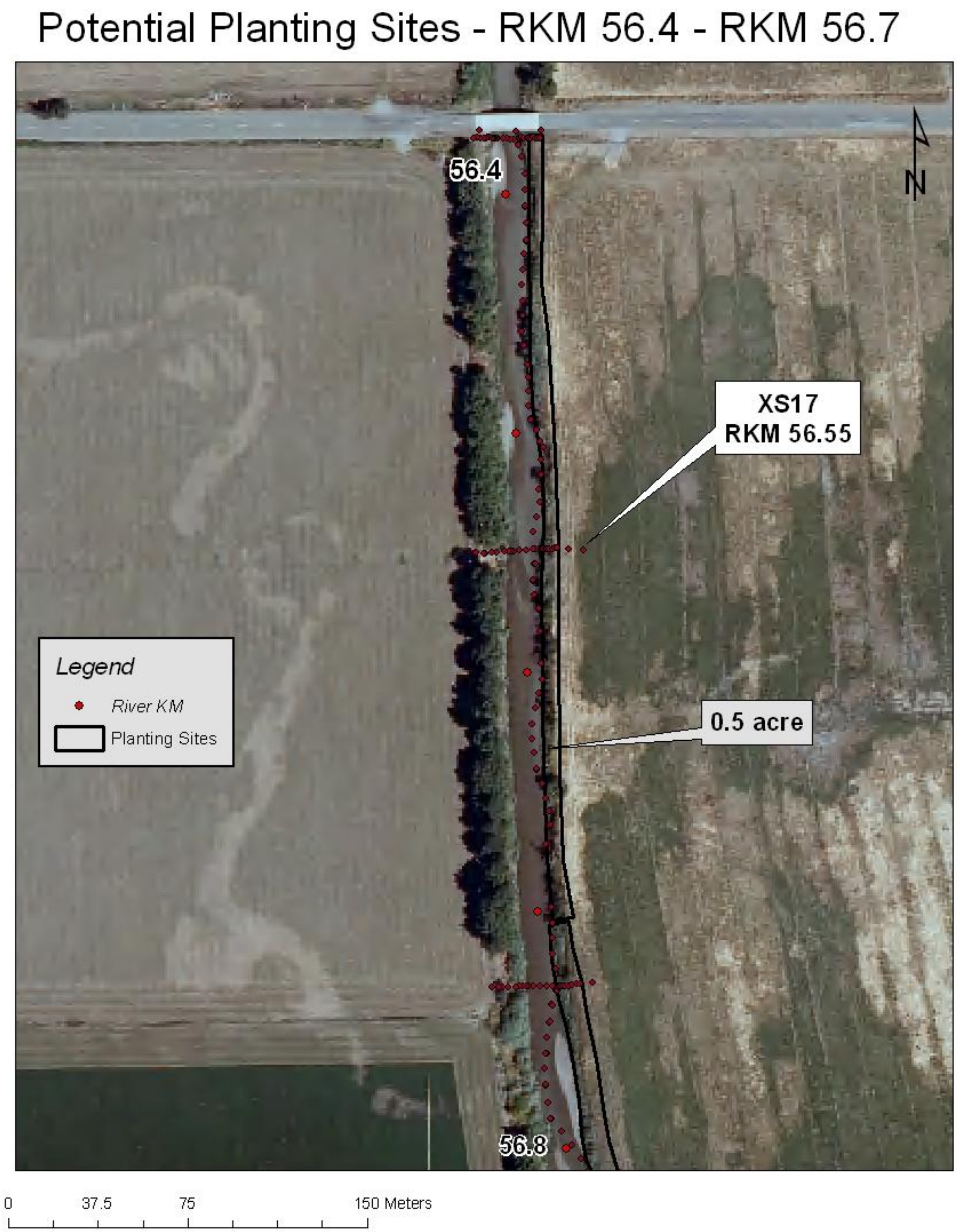
X-section	RKM	Left Bank Height	Right Bank Height	Thalweg to Left Bank	Thalweg to Right Bank	Left Bank to Right Bank
1	58.4	3.5	3.3	25.2	7.1	32.3
2	58.2	3.6	3.5	7.6	33	40.6
3	58.15	3.7	3.7	22.4	16.3	38.7
4	58.1	4.2	4.2	29.6	4	33.6
5	58.1	3.8	3.8	41.4	2	43.4
6	58.05	3.9	3.7	46.8	2.5	49.3
7	58	5.1	5	8.4	28.9	37.3
8	57.9	4.1	3.2	15.3	25.8	41.1
9	57.7	3.8	4.1	23.7	30.4	54.1
10	57.6	4.3	4	9.1	31.1	40.2
11	57.45	4.2	4.3	28.1	9.5	37.6
12	57.3	3.5	3.9	15.2	21.2	36.4
13	57.15	3.6	3.8	11	20	31
14	57	3.9	4.2	17.3	10.5	27.8
15	56.85	4.1	4.3	8.5	22.9	31.4
16	56.75	4.3	4	8	20.9	28.9
17	56.55	3.4	3.9	8.6	21.1	29.7
18	56.4	4.3	4.6	8.5	17.3	25.8
Average		4.0	4.0			36.6

Scott River morphology - 1993 & 2010
RKM 58.4 - RKM 57.8



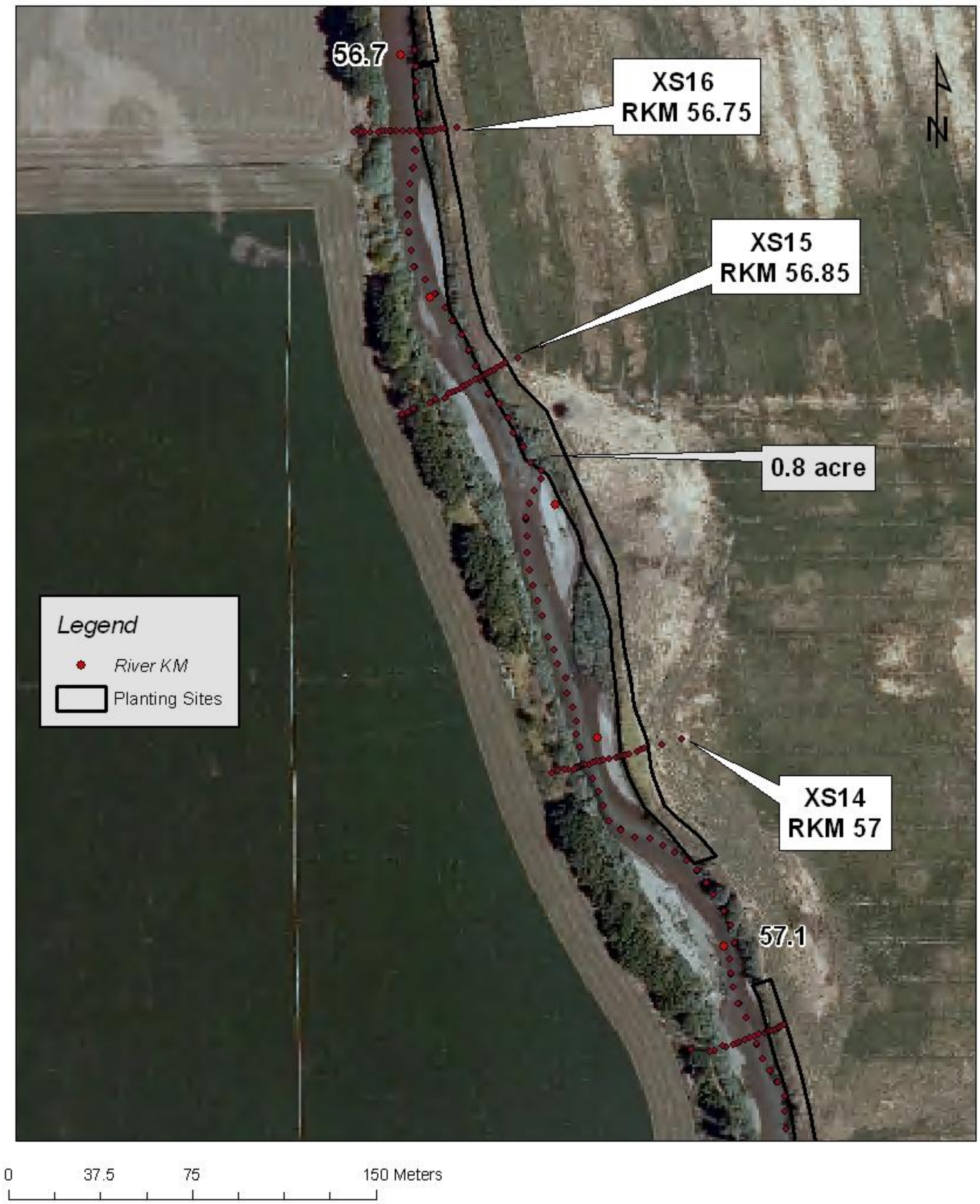
Map 4 – aerial images of reach with vertical cut bank – 1993 and 2010

Map 5 – aerial images of reach with successful riparian plantings on West bank – 1993 and 2010

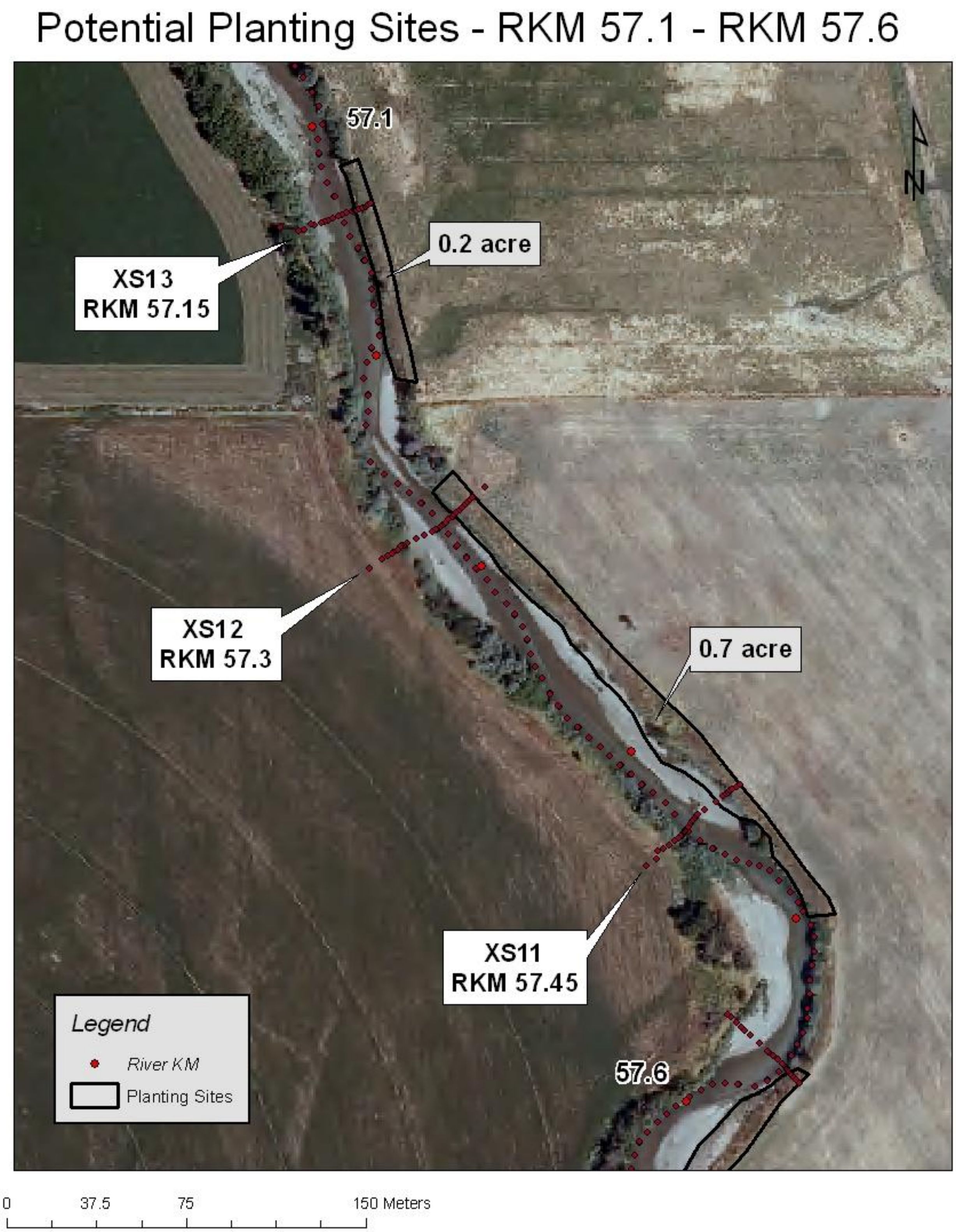


Map 6 – potential planting sites – RKM 56.4 – RKM 56.7

Potential Planting Sites - RKM 56.7 - RKM 57.1

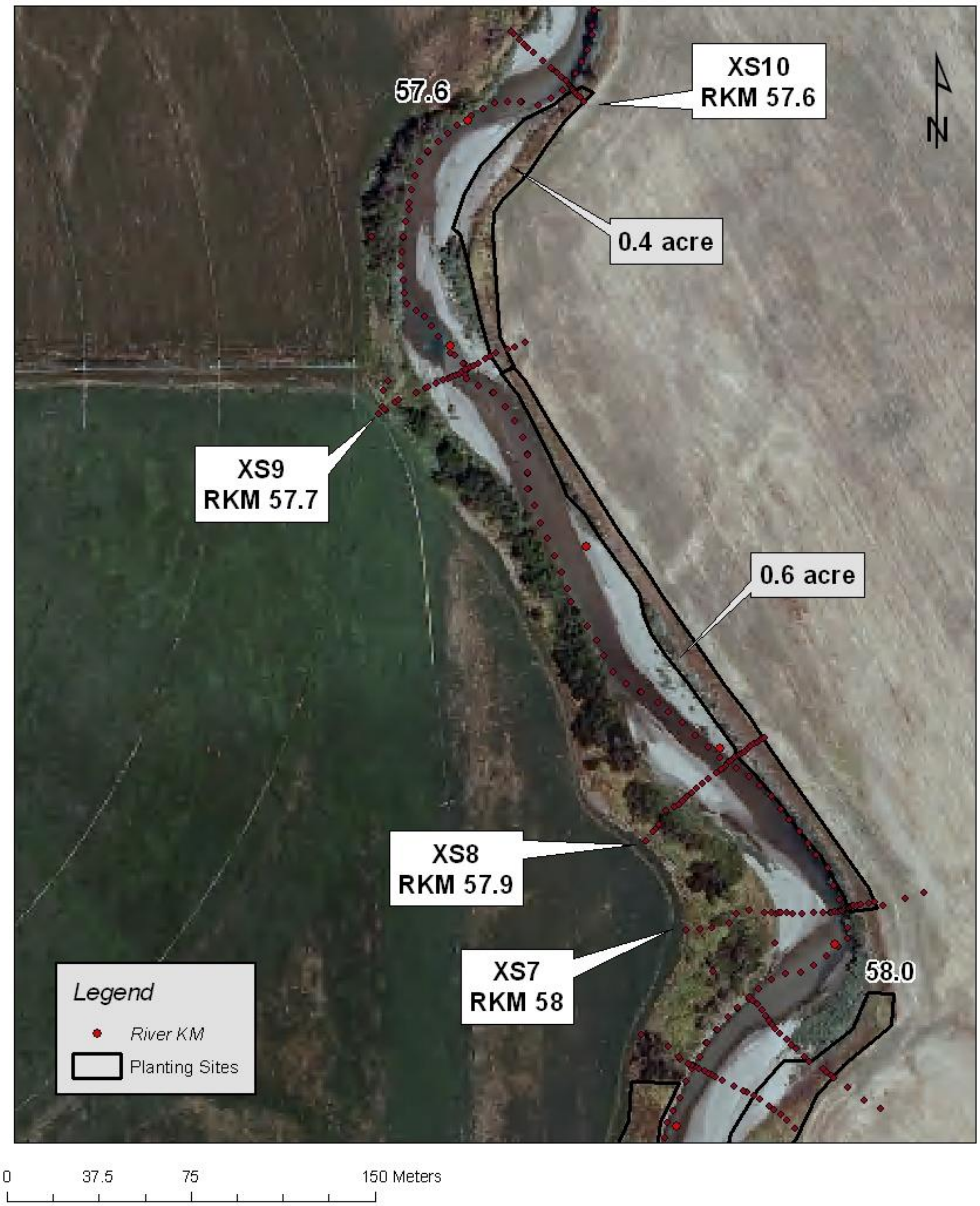


Map 7 – potential planting sites – RKM 56.7 – RKM 57.1

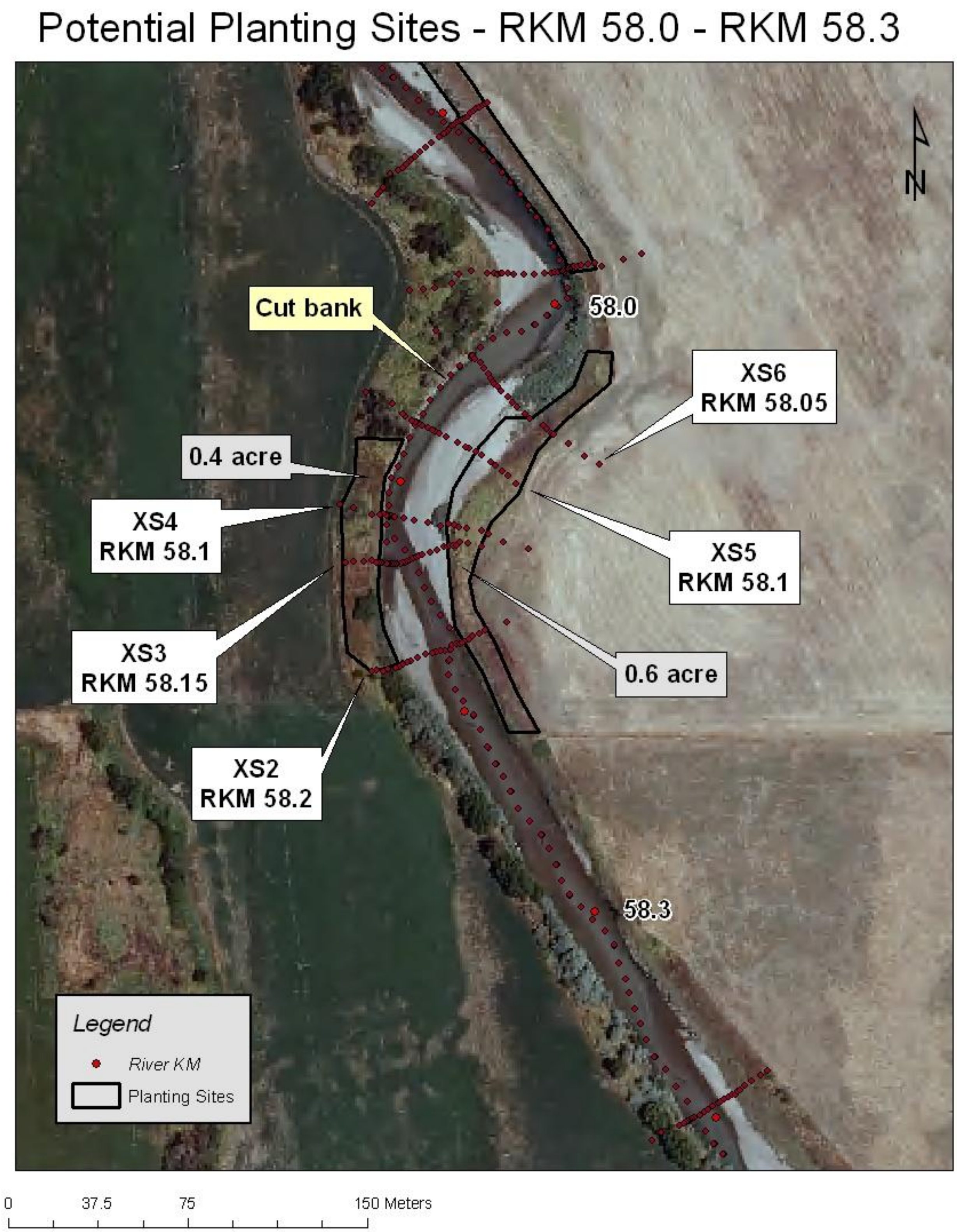


Map 8 – potential planting sites – RKM 57.1 – RKM 57.6

Potential Planting Sites - RKM 57.6 - RKM 58.0



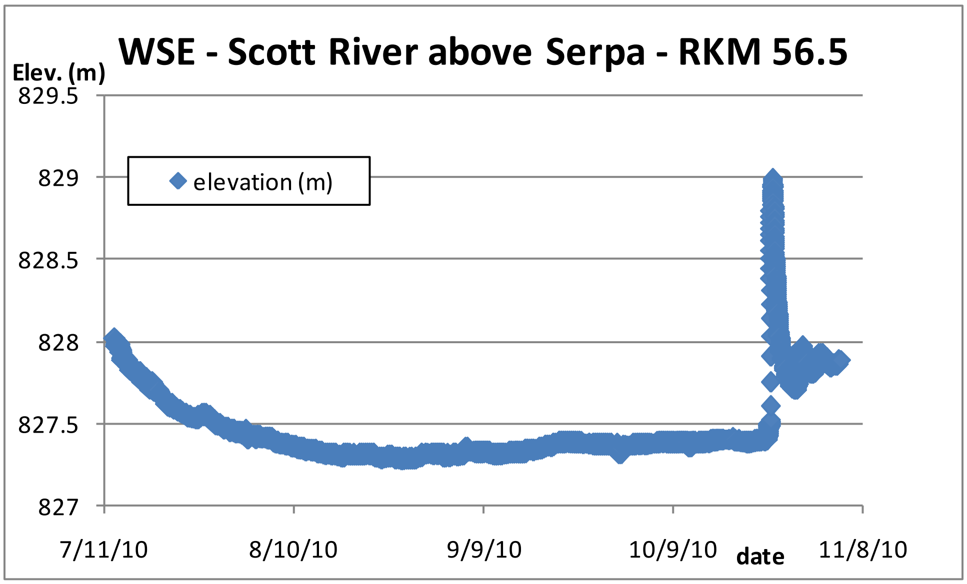
Map 9 – potential planting sites – RKM 57.6 – RKM 58.0



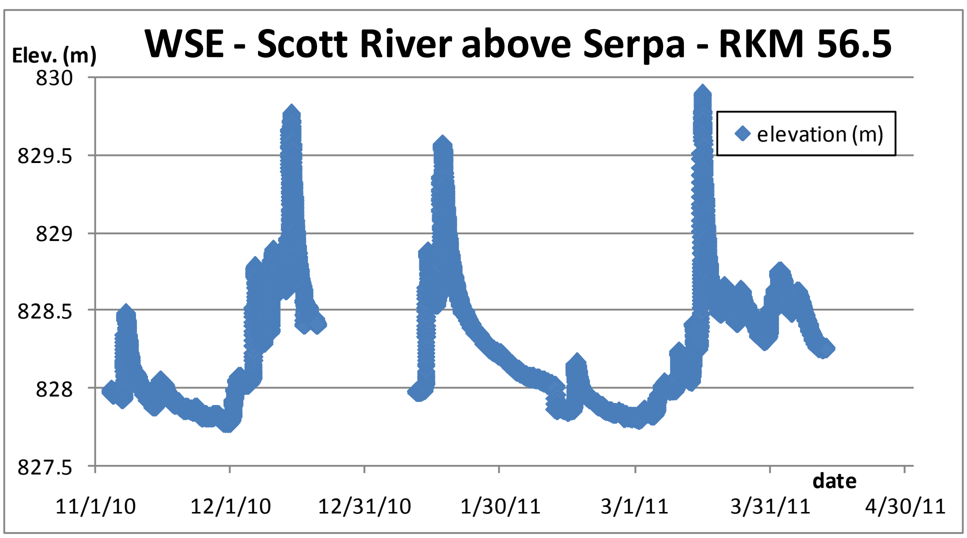
Map 10 – potential planting sites – RKM 58.0 – RKM 58.3

Water surface elevation during summer and winter flows

A stream gauging station has been operated in the Scott River above Serpa Lane (RKM 56.5) since 2008. This station consists of a pressure transducer on the bottom of a pool. The pool's depth (stage height) is calculated. The elevation of the pool bottom was surveyed allowing for the conversion of stage height to water surface elevation during the period in which the pressure transducer was in place. The water surface elevation (wse) during the low flow period of summer (Graph 21) and the high flow period of winter and early spring runoff (Graph 22) was calculated for WY10-WY11.

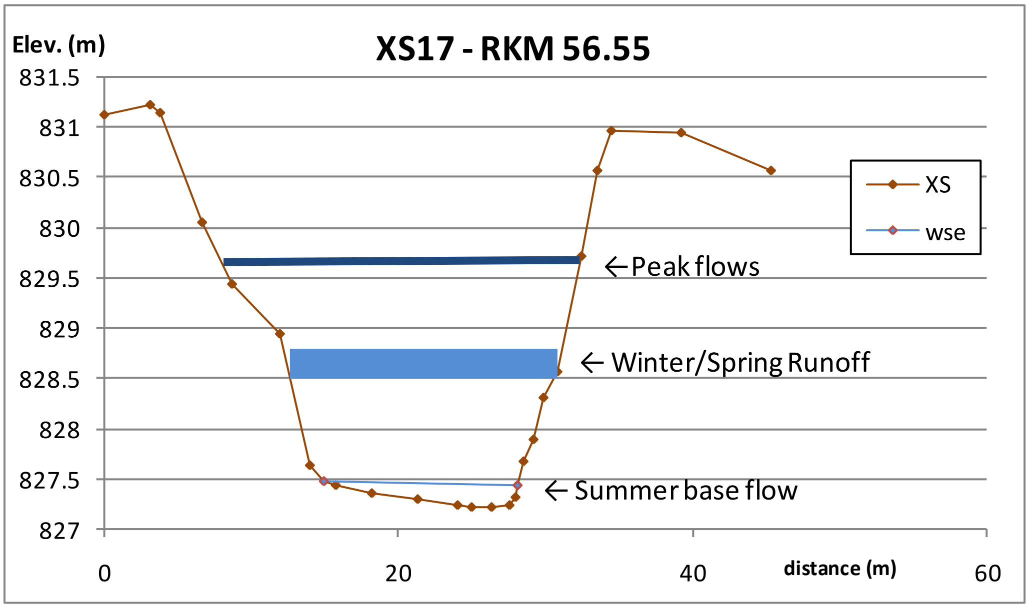


Graph 21 – water surface elevation during the summer of 2010

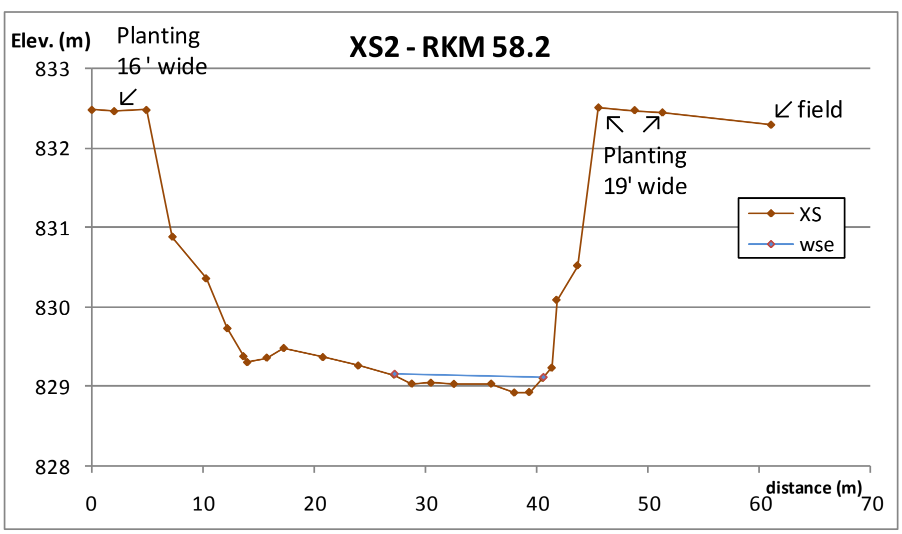


Graph 22 – water surface elevation during winter and early spring runoff – WY2011

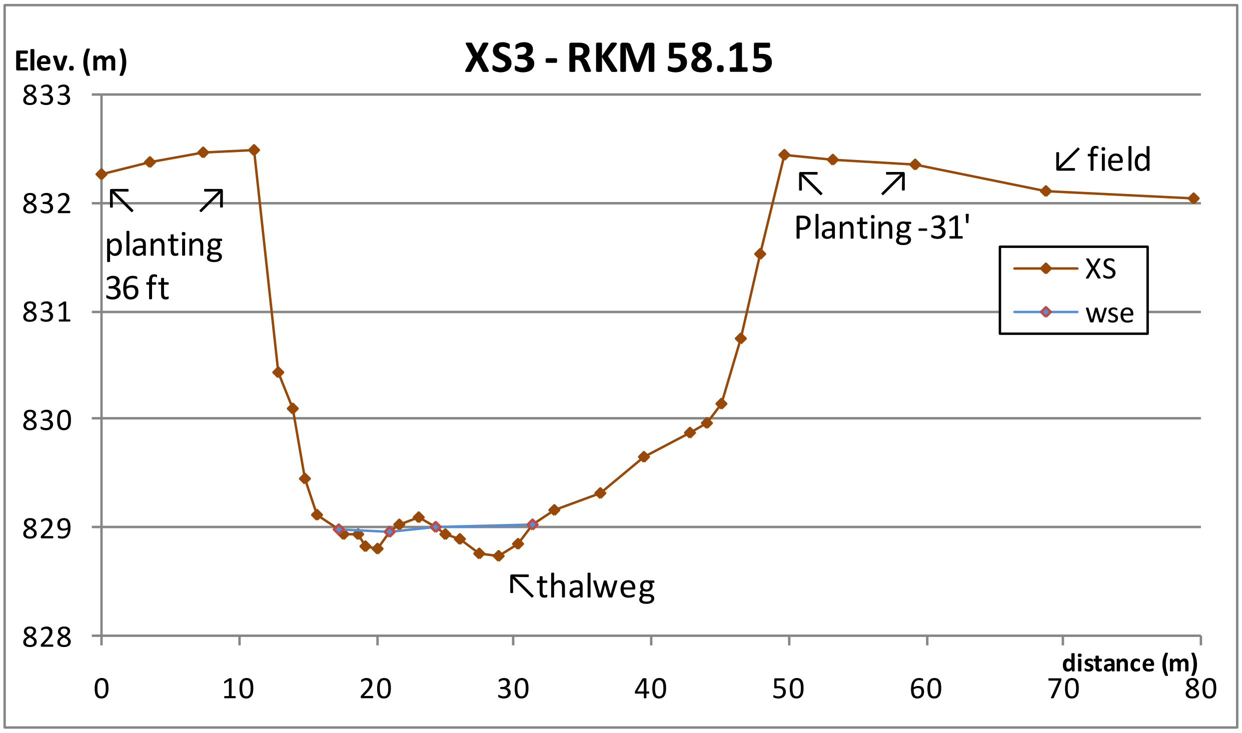
A transect (XS17) was surveyed directly upstream of gauged pool. The elevation for summer base flow , average winter runoff and peak flow events was transposed onto the upstream transect (Graph 23). This demonstrates that the water surface elevation of winter and spring runoff is approximately 1 meter higher than the elevation of summer base flow. The water surface elevation for the observed peak flows are greater than 2 meters higher than the elevation of summer base flow. This analysis will assist in the determination of the lowest elevation of desired plantings.



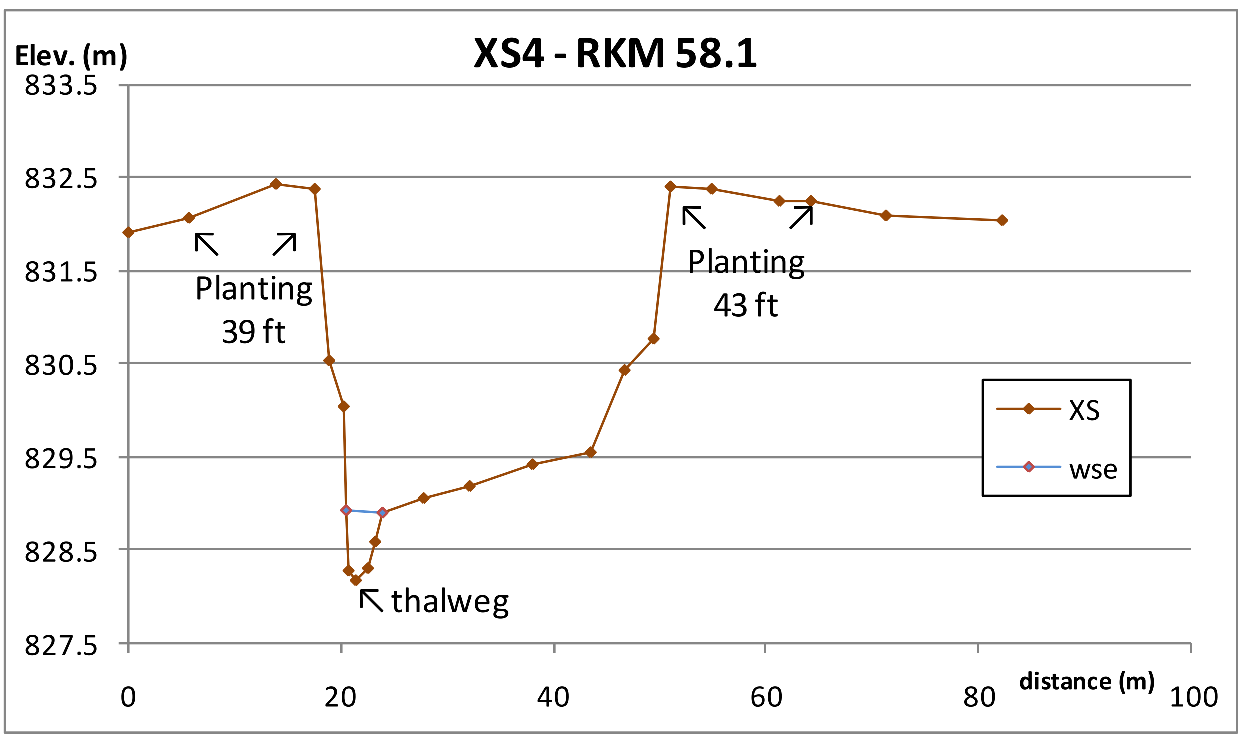
Graph 23 – Calculated water surface elevation during summer and winter flow regimes



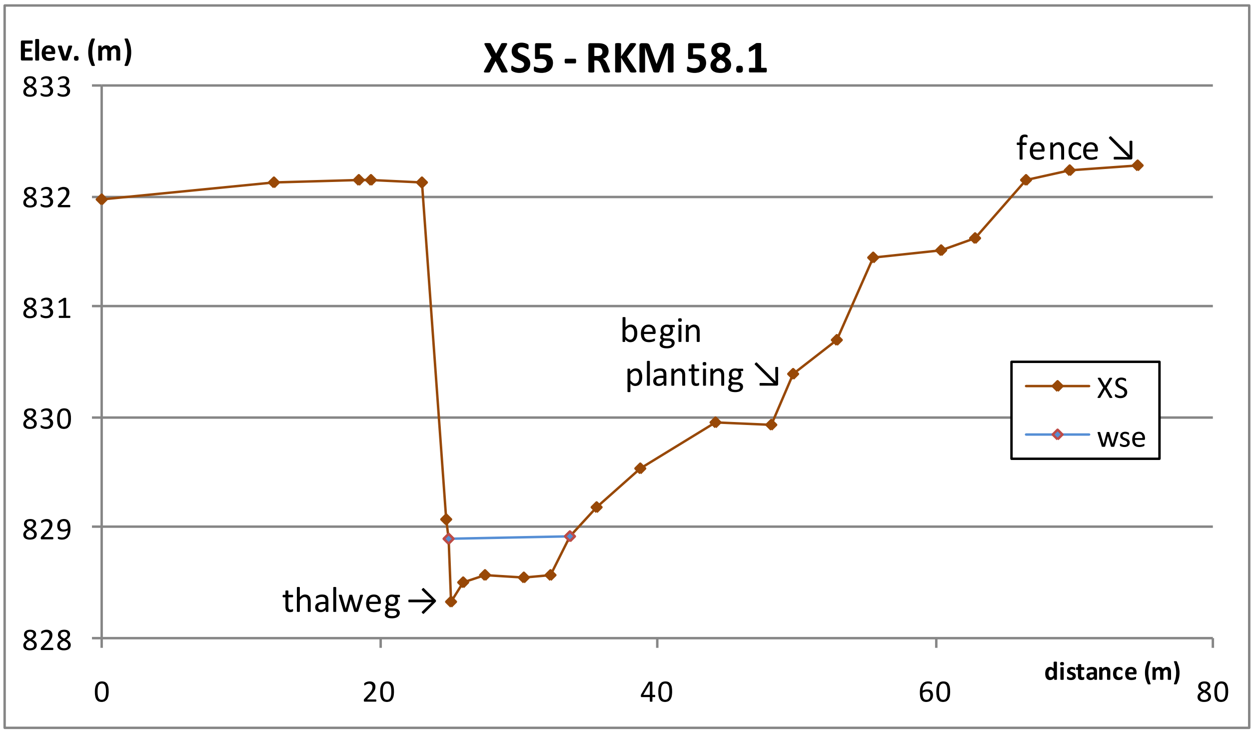
Graph 24 – proposed planting locations – RKM 58.2



Graph 25 – proposed planting locations – RKM 58.15



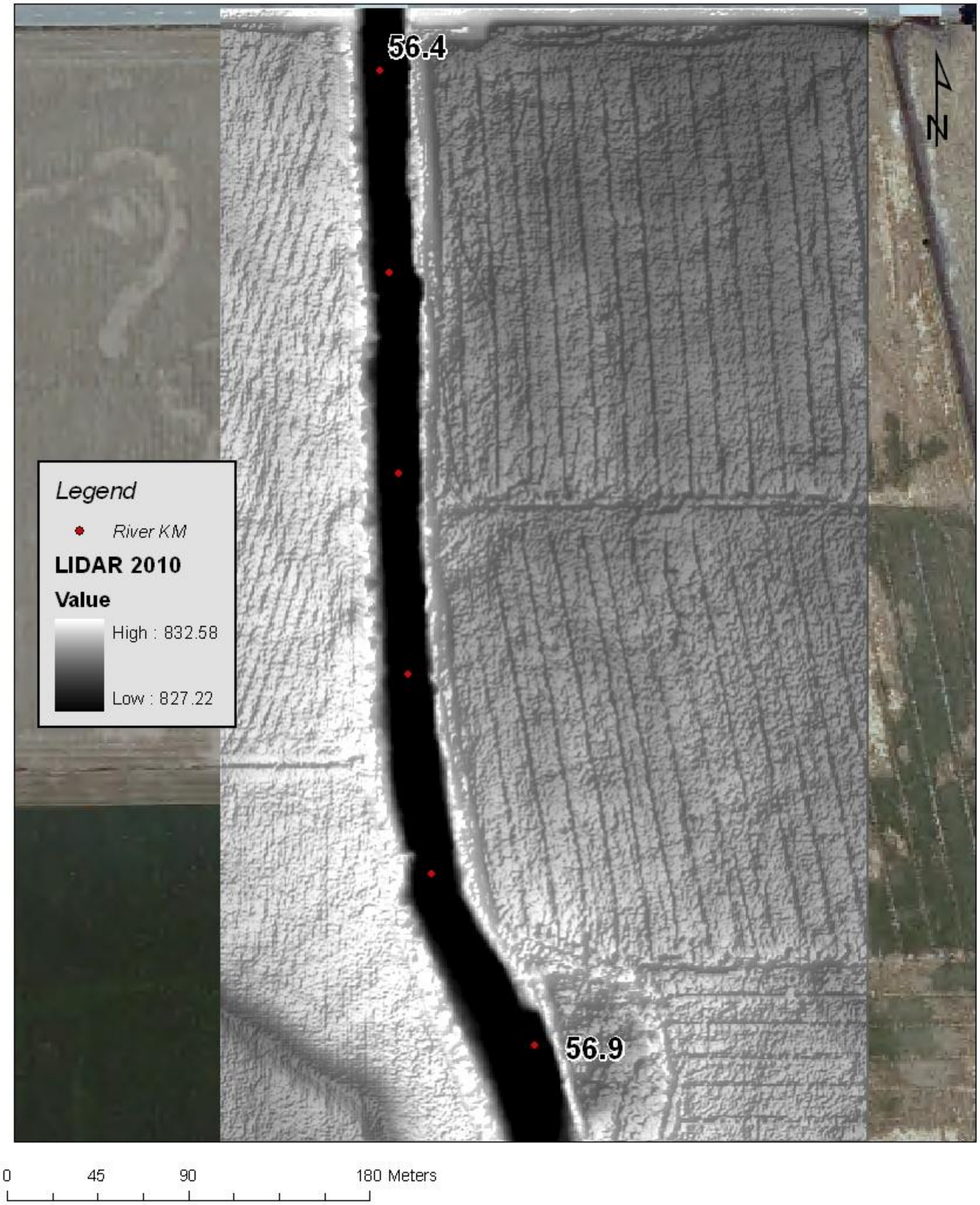
Graph 26 – proposed planting locations – RKM 58.15



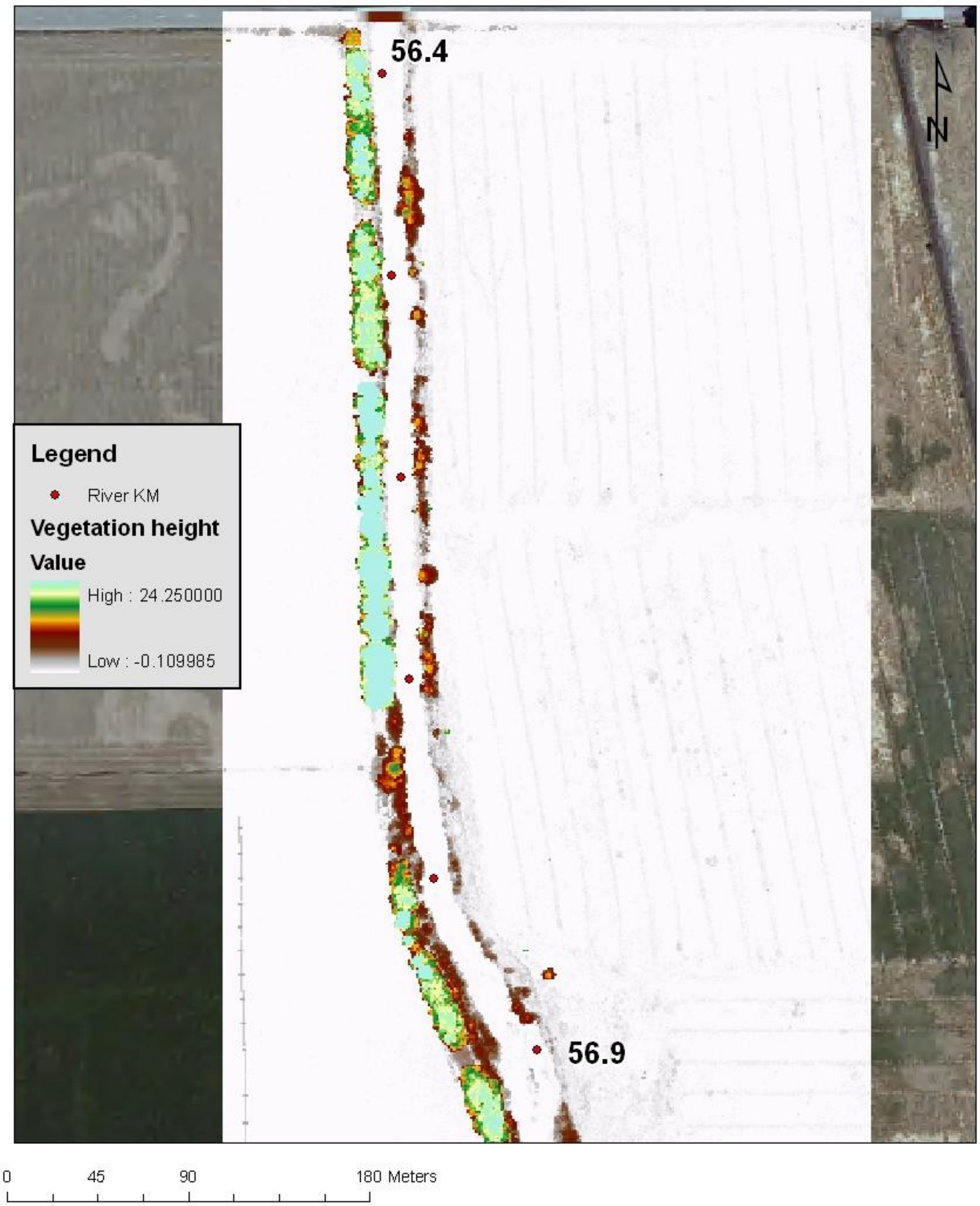
Graph 27 – proposed planting locations – RKM 58.1

RKM 56.4 - 56.9 - NAIP 2010

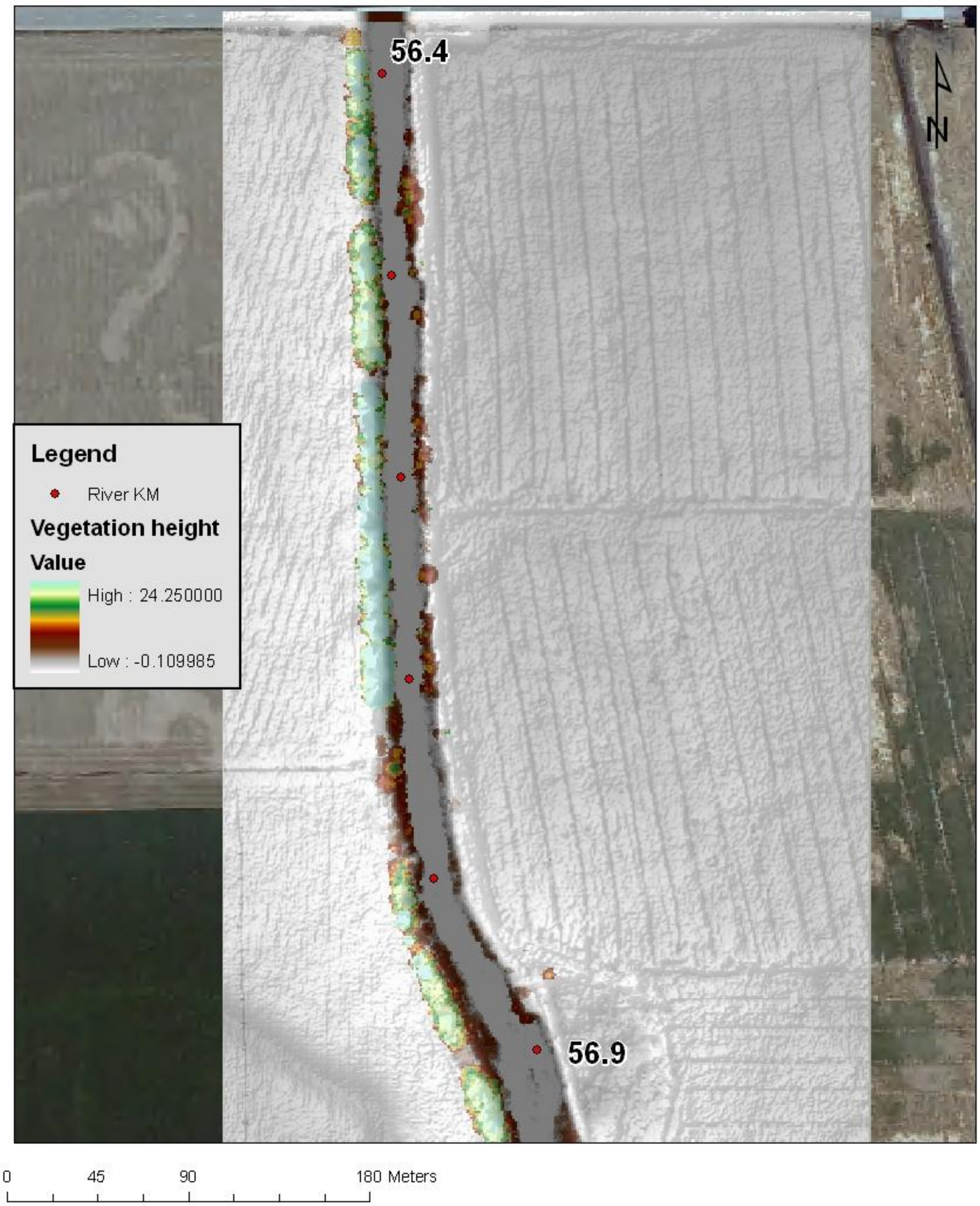
RKM 56.4 - 56.9 - LIDAR - Bare Earth



RKM 56.4 - 56.9 - Vegetation Height

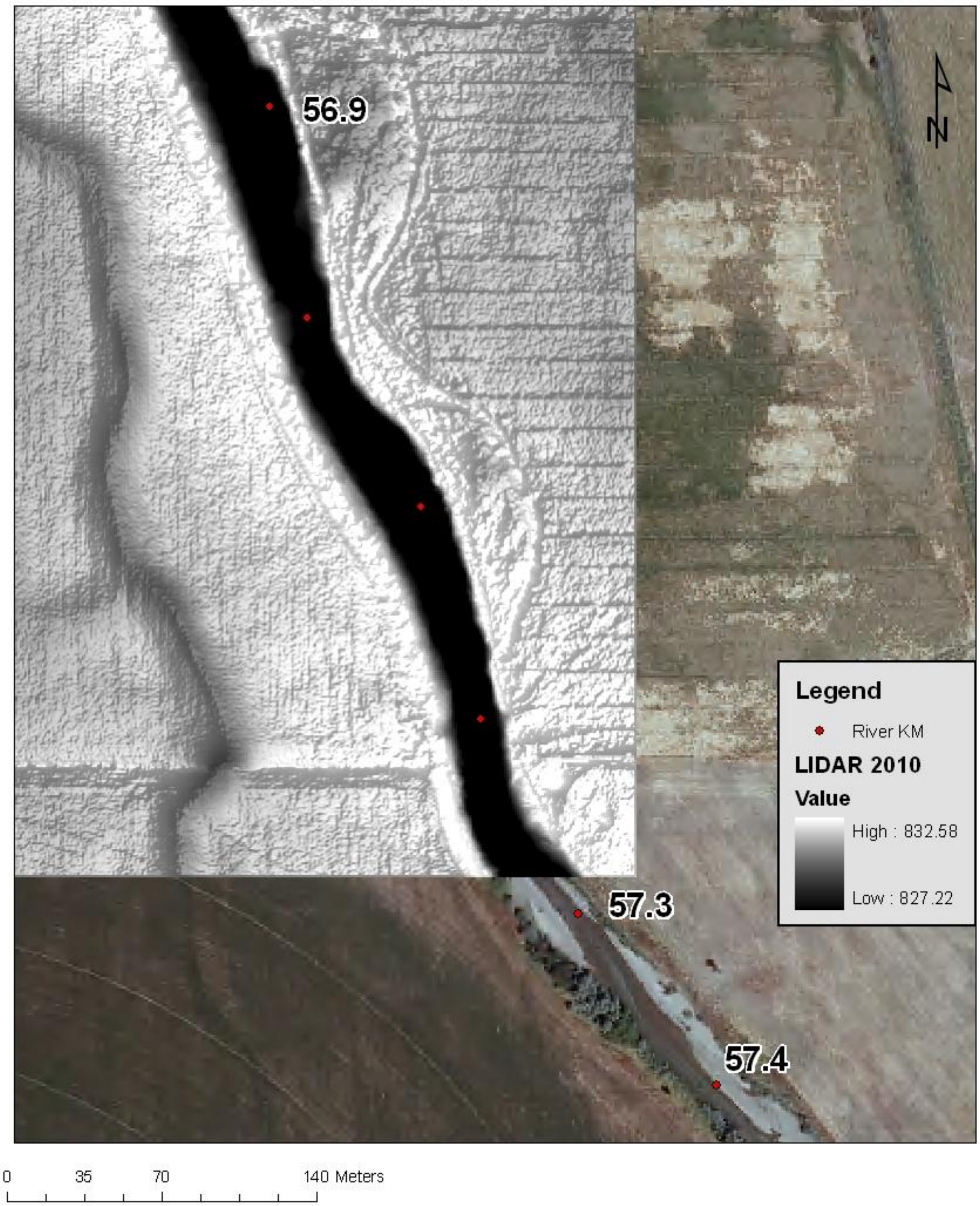


RKM 56.4 - 56.9 - Vegetation Height

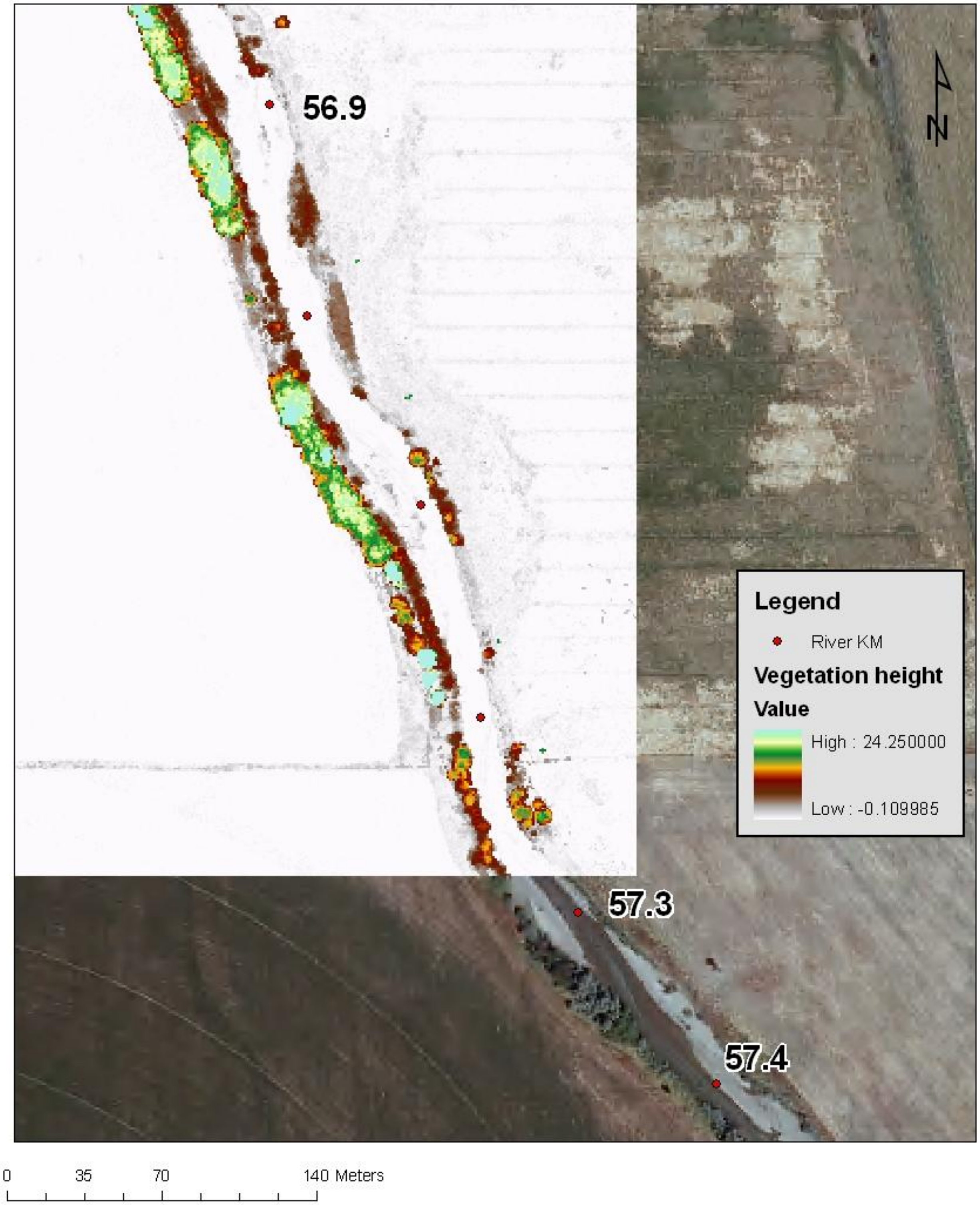


RKM 56.9 - 57.3 - NAIP 2010

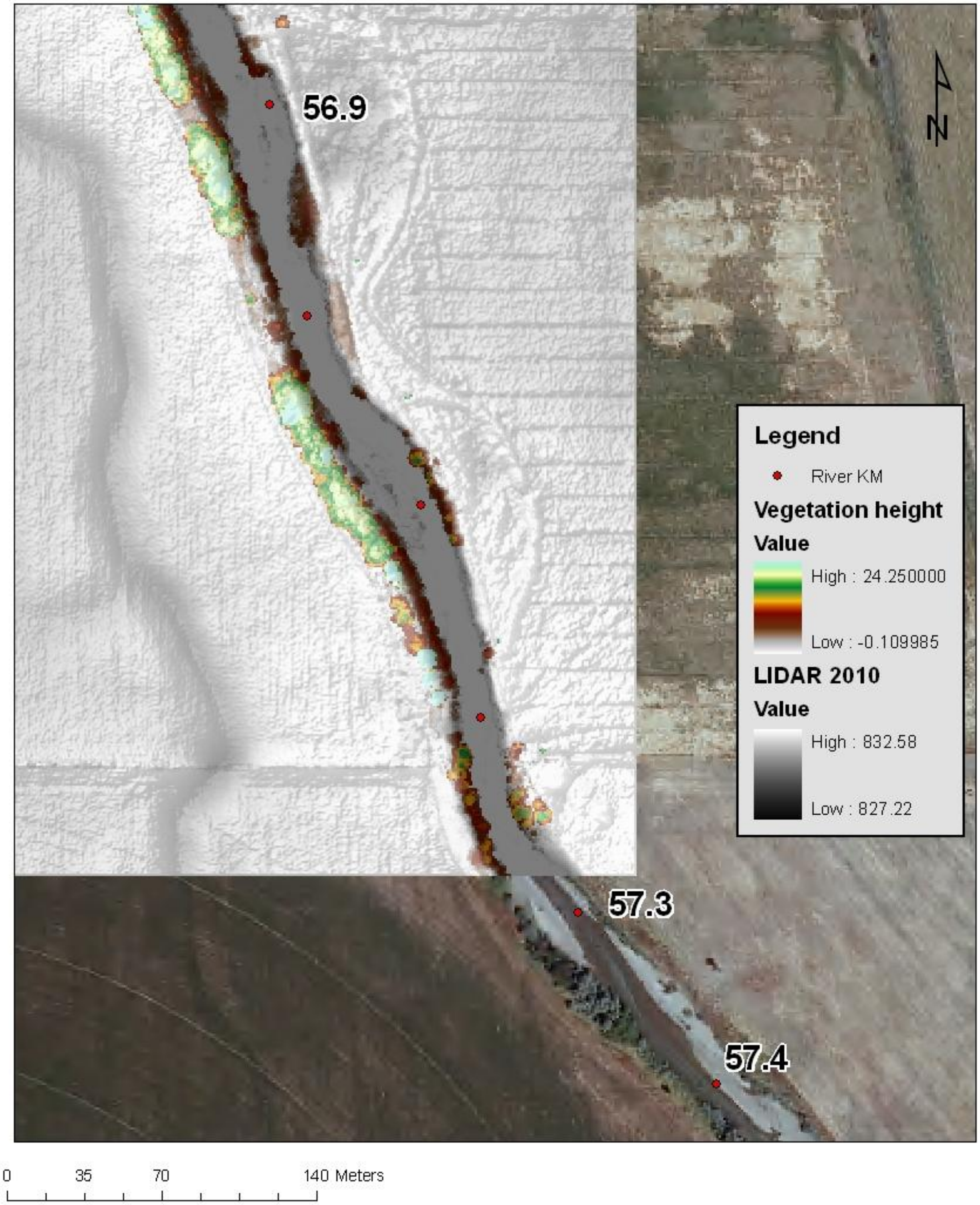
RKM 56.9 - 57.3 - Bare Earth



RKM 56.9 - 57.3 - Vegetation height

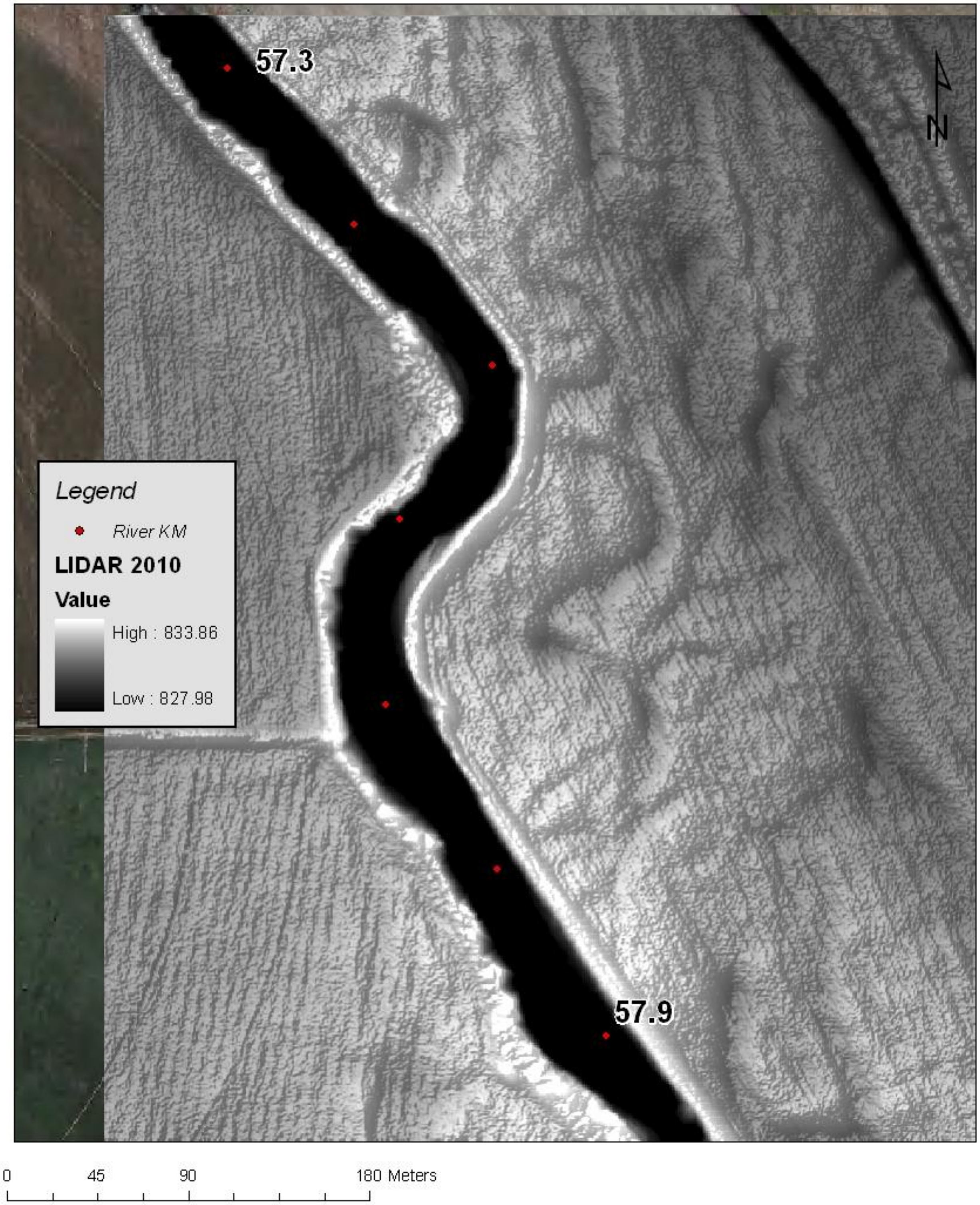


RKM 56.9 - 57.3 - Vegetation height

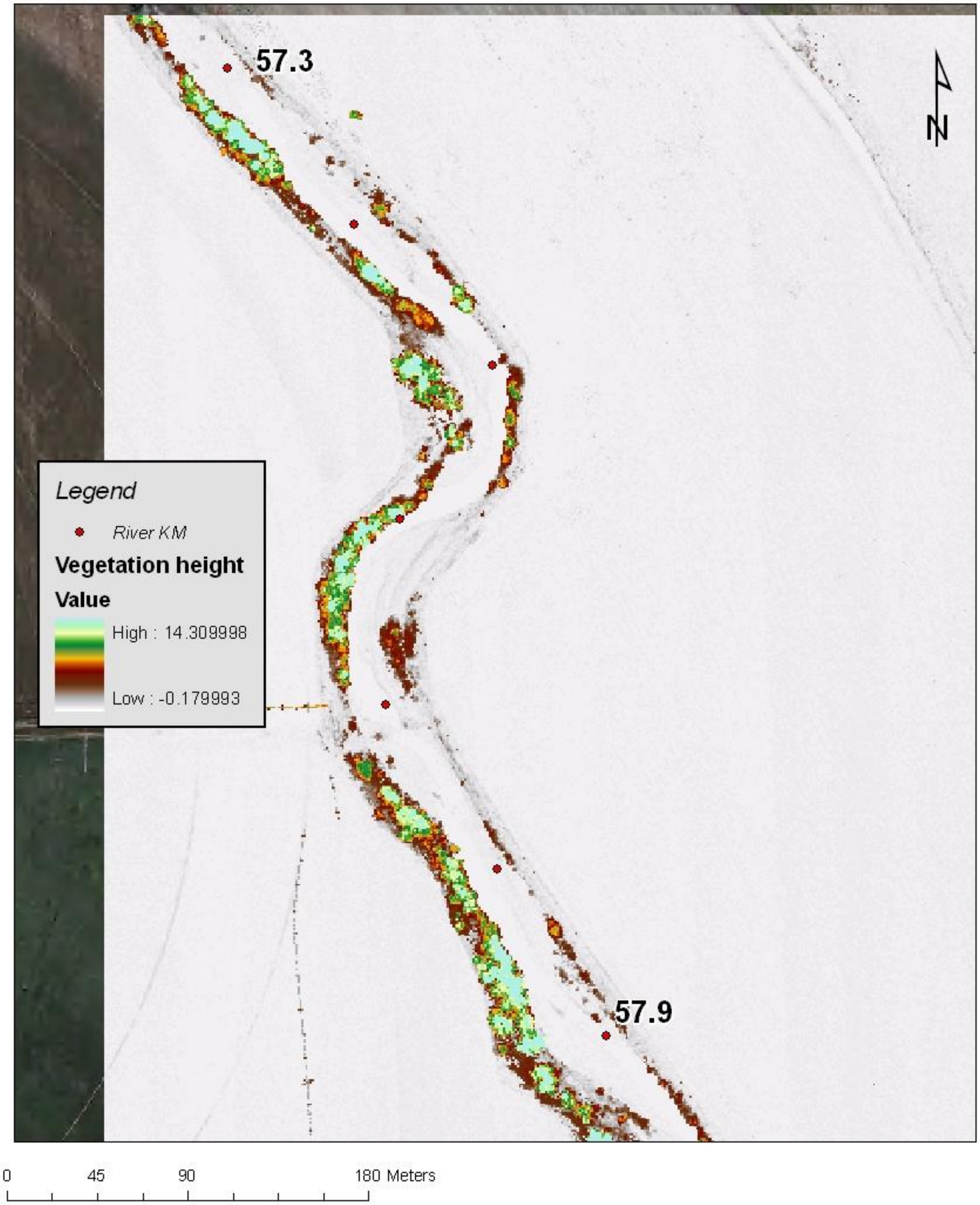


RKM 57.3 - 57.9 - NAIP 2010

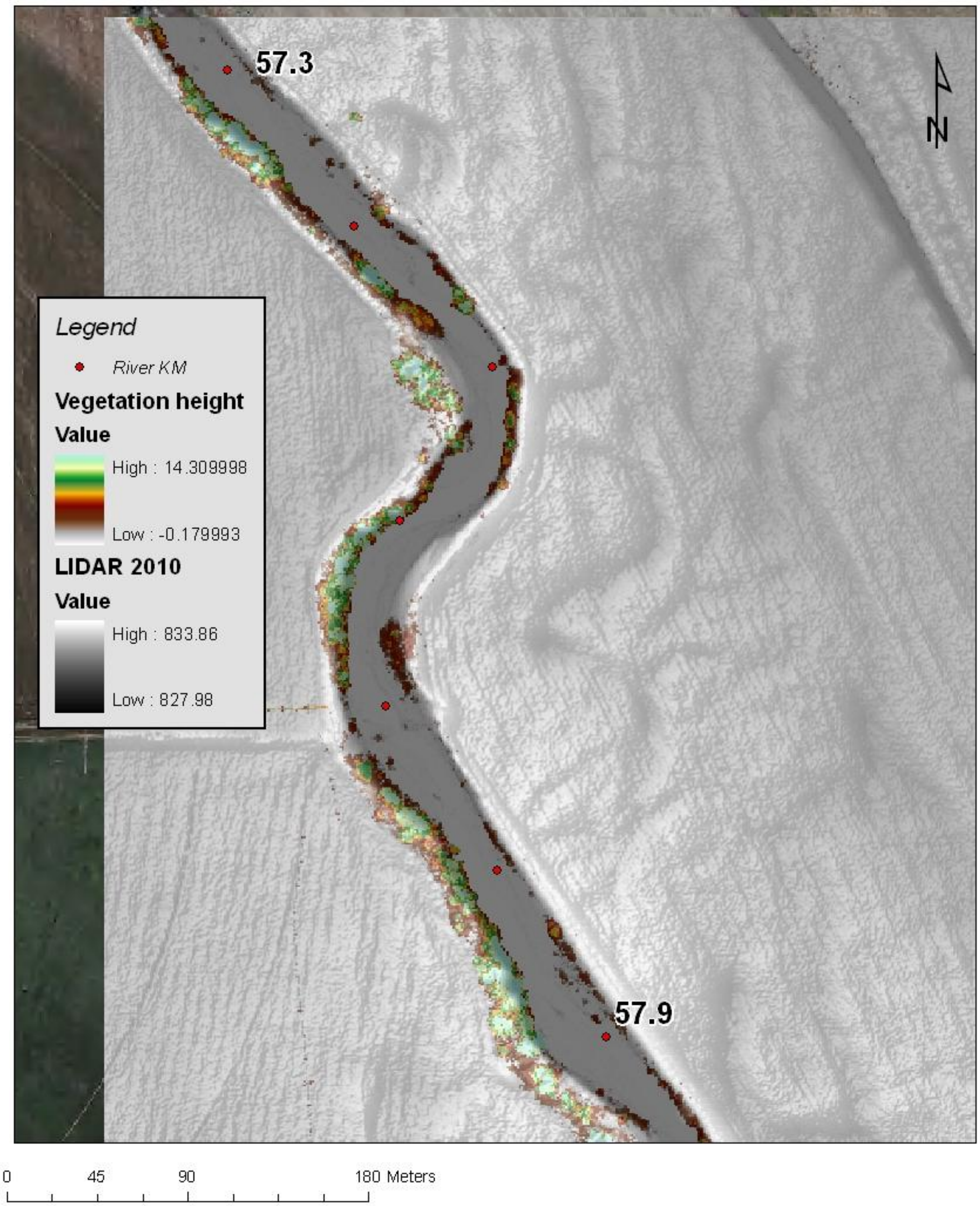
RKM 57.3 - 57.9 - LIDAR - Bare Earth



RKM 57.3 - 57.9 - LIDAR - Vegetation Height

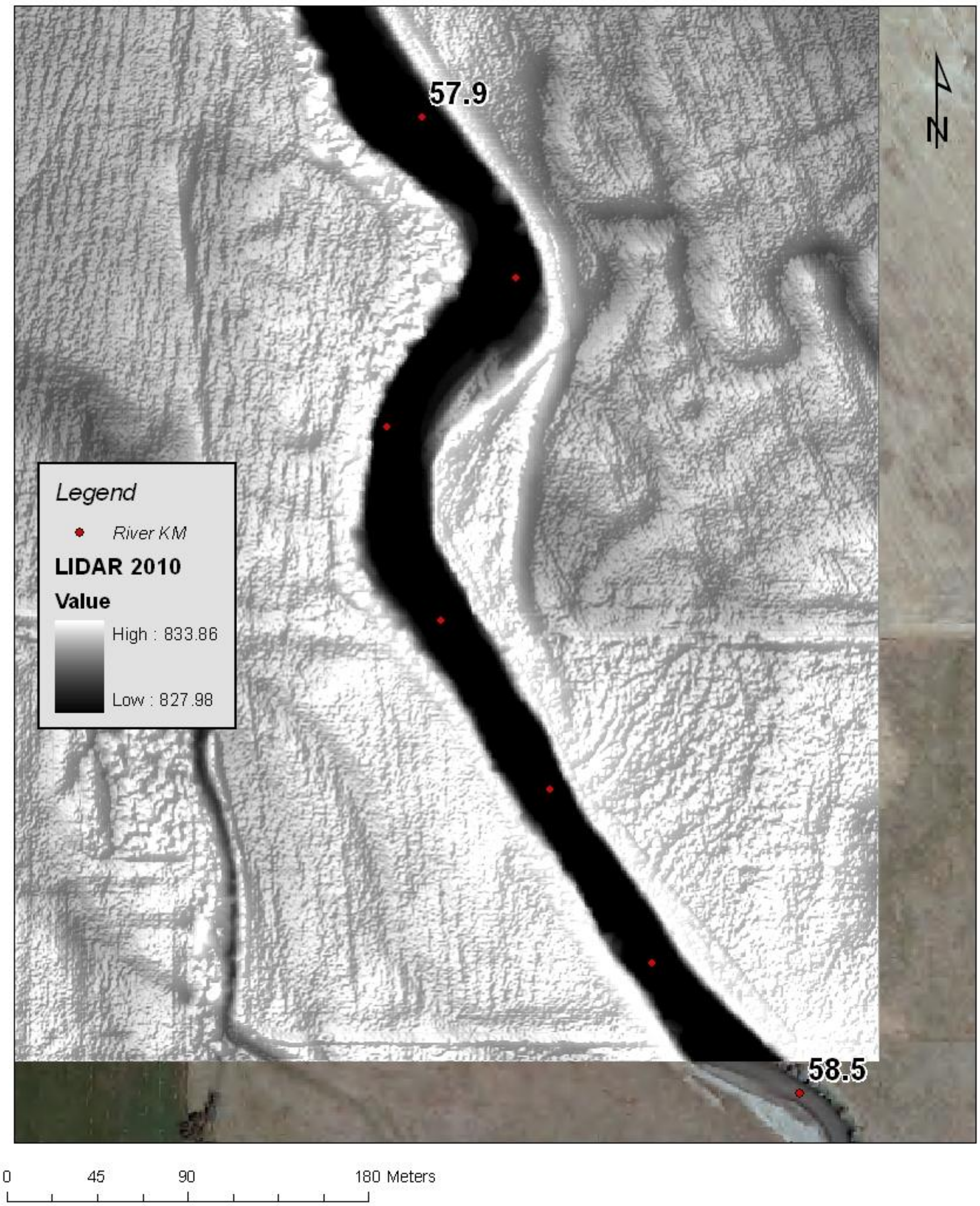


RKM 57.3 - 57.9 - LIDAR - Vegetation Height

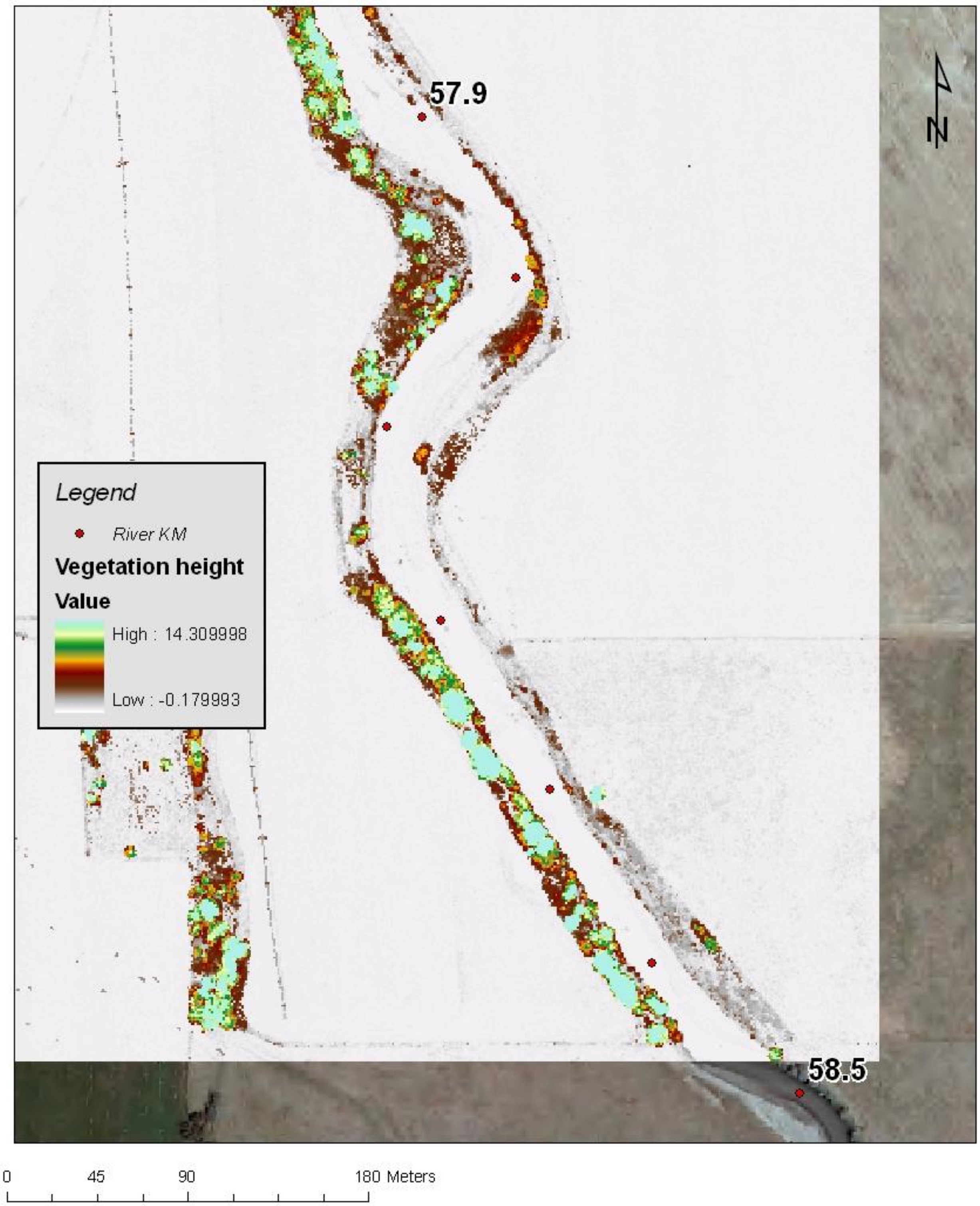


RKM 57.9 - 58.5 - NAIP 2010

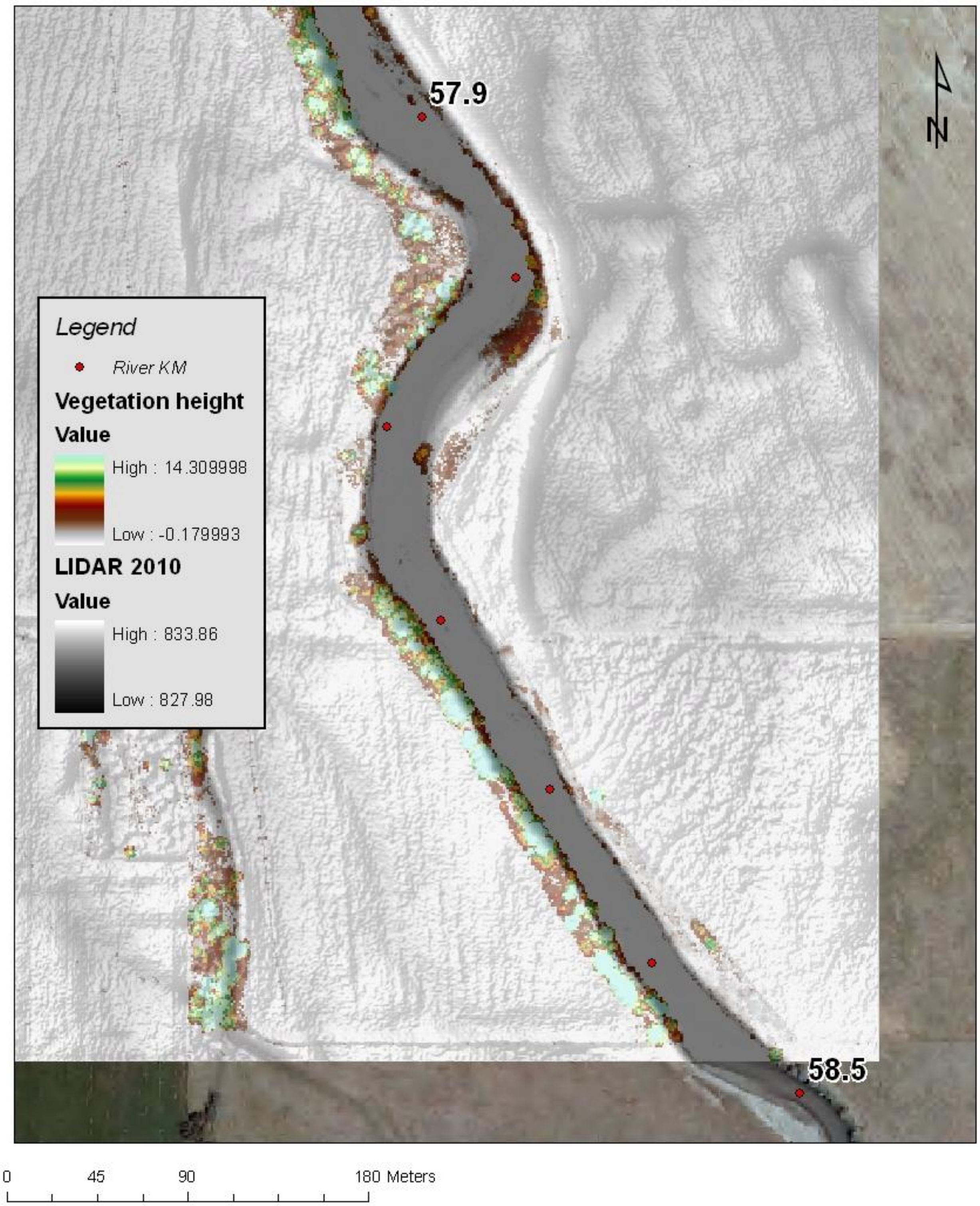
RKM 57.9 - 58.5 - LIDAR - Bare earth



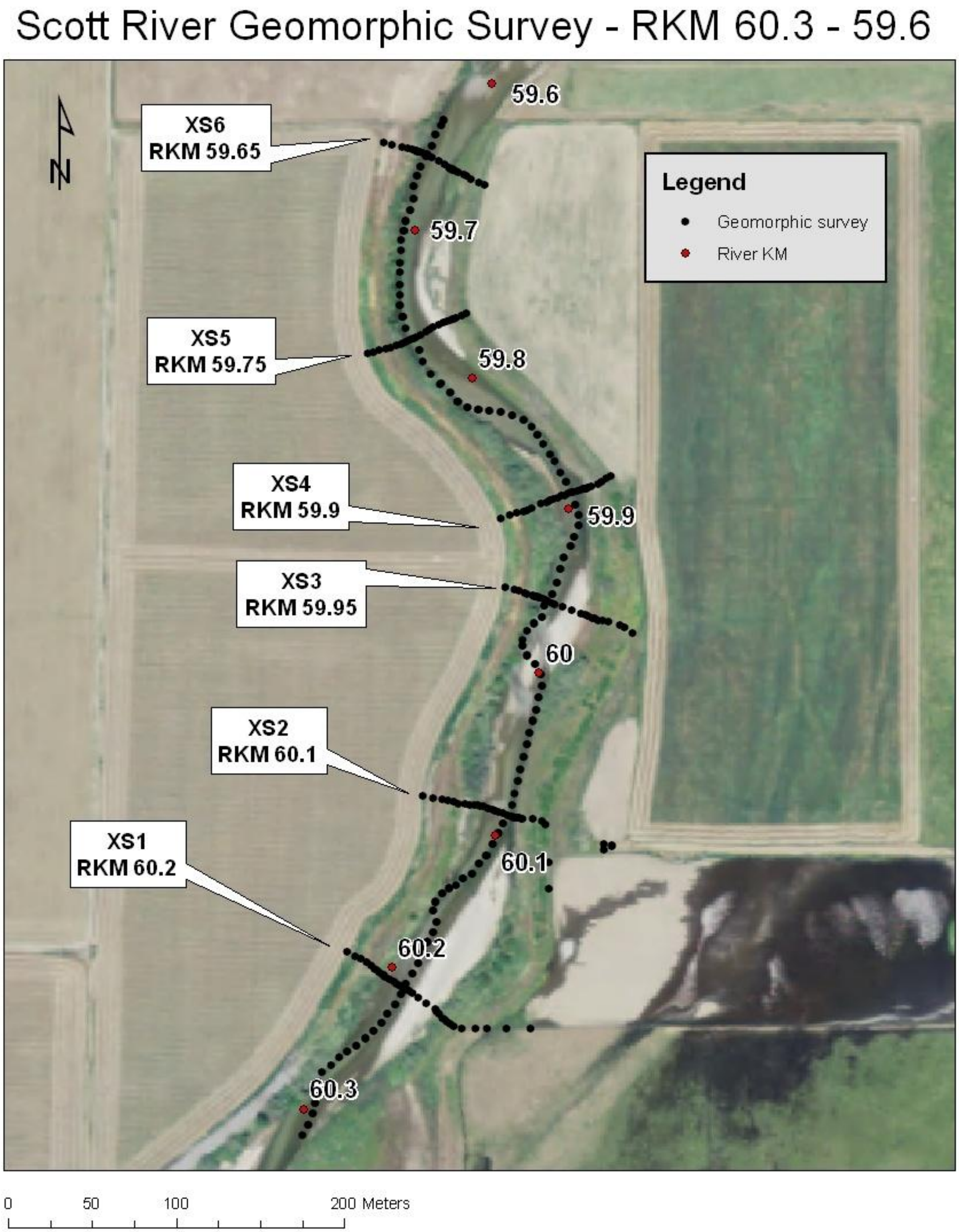
RKM 57.9 - 58.5 - LIDAR - Vegetation Height



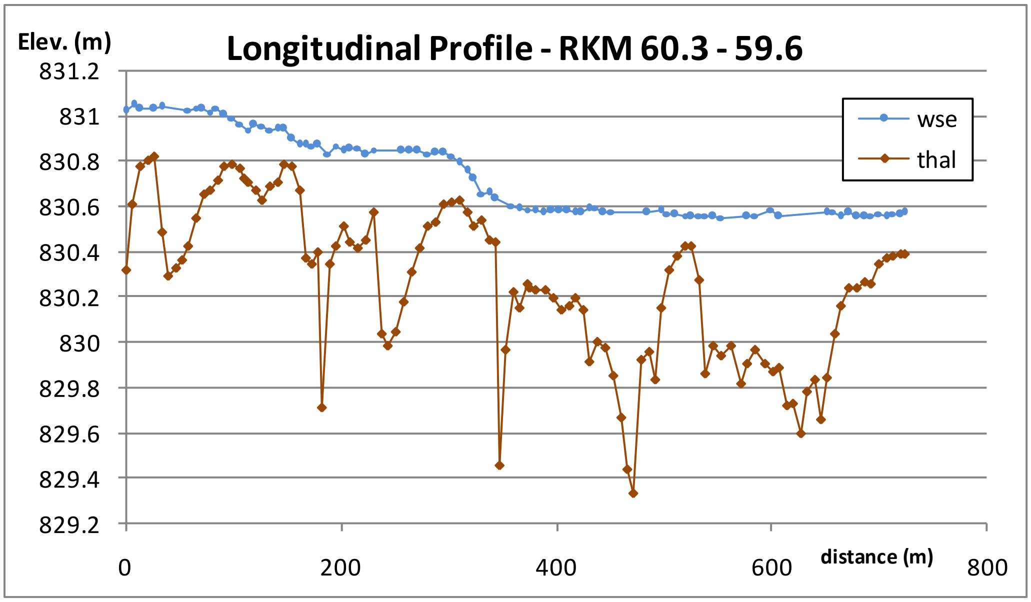
RKM 57.9 - 58.5 - LIDAR - Vegetation Height



RKM 60.3 – RKM 59.6 – Cooper Ranch

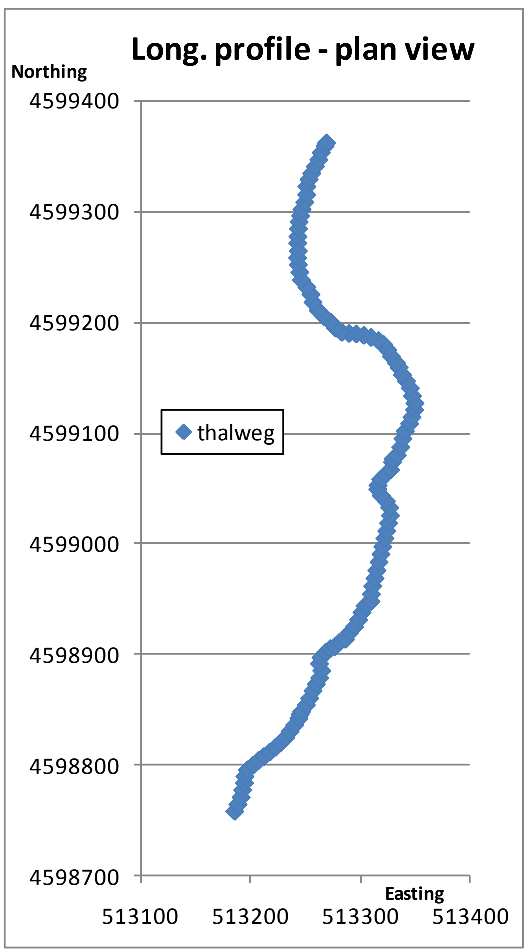


Map 1 – Surveyed reach – RKM 60.3 – RKM 59.6



Graph 1 – longitudinal profile of thalweg and water surface elevation (wse) – RKM 60.3 – RKM 59.6

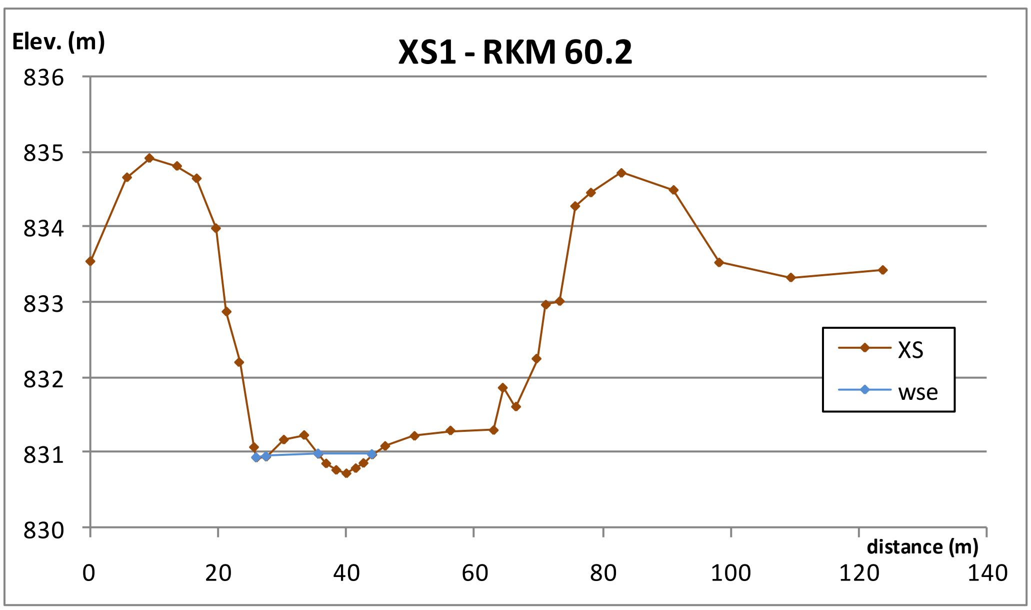
The slope through this reach is approximately 0.1%.



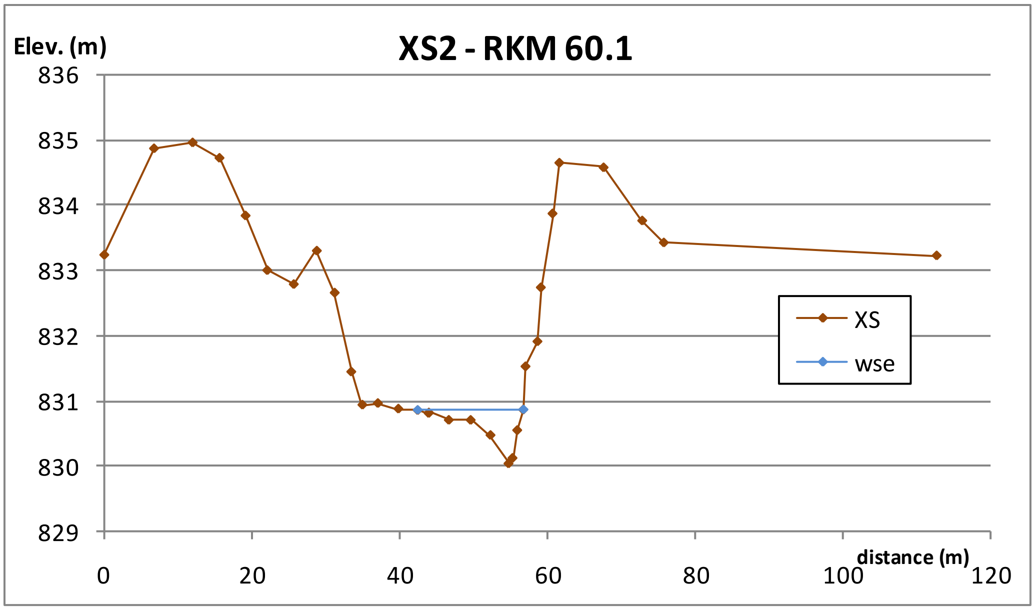
Graph 2 – Plan View of Longitudinal Profile

Stream KM	Potential Shade	Current Shade	Potential Shade Increase
60.2	0.22	0.08	0.14
60.1	0.39	0.02	0.37
60	0.38	0.14	0.24
59.9	0.58	0.09	0.49
59.8	0.48	0.08	0.4
59.7	0.38	0.08	0.3
59.6	0.37	0.01	0.36

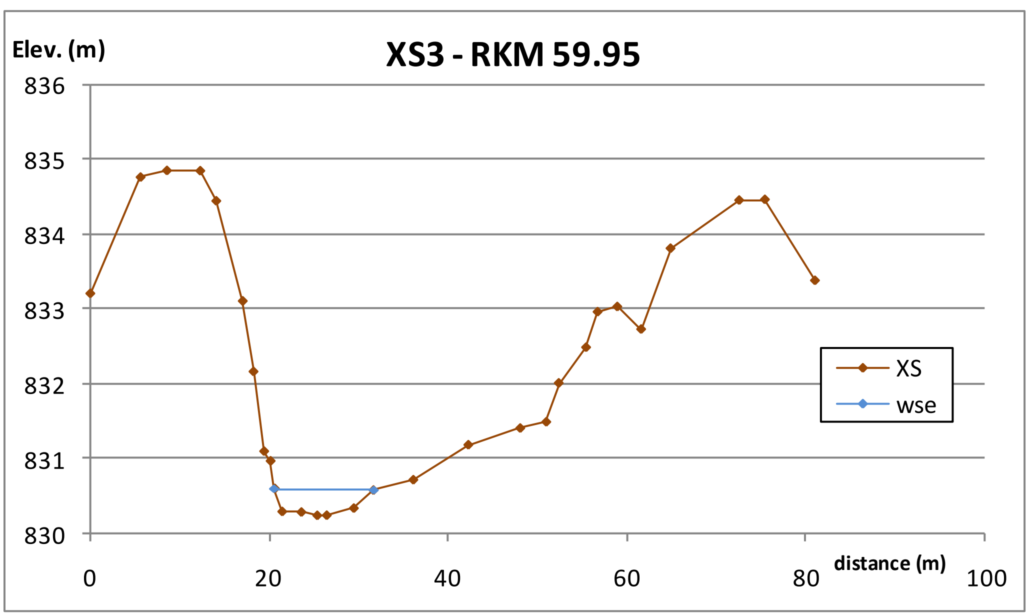
Table 1 – Potential and current shade from NCRWQCB Staff Report for Scott River TMDL



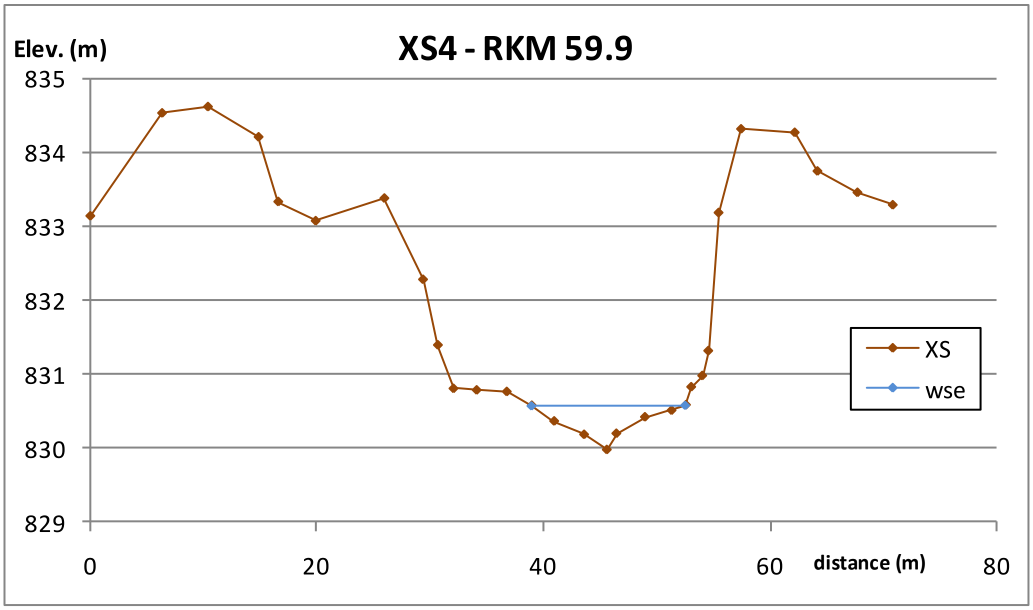
Graph 3 – XS1 at RKM 60.2



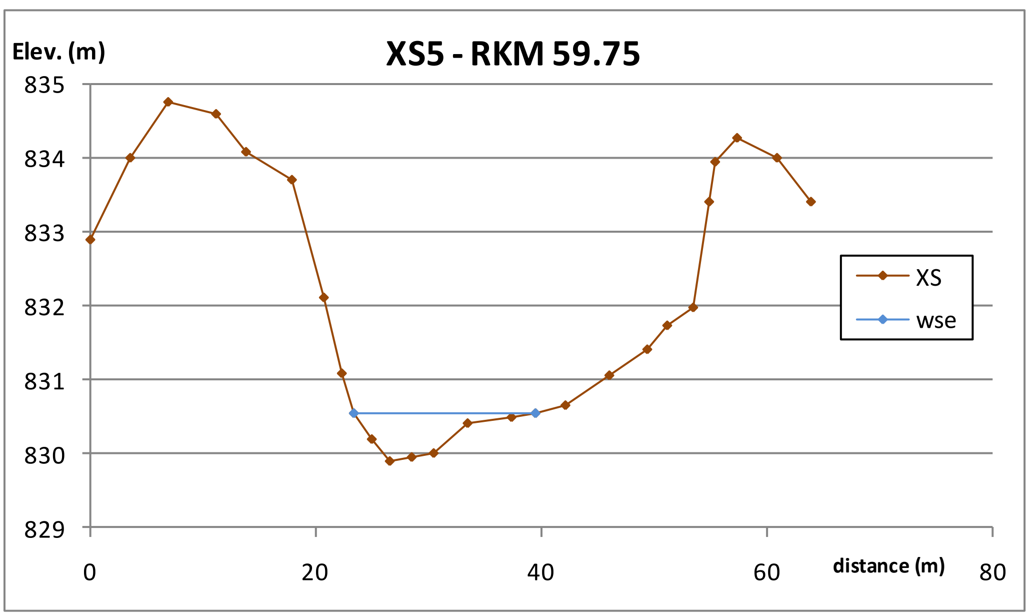
Graph 4 – XS2 at RKM 60.1



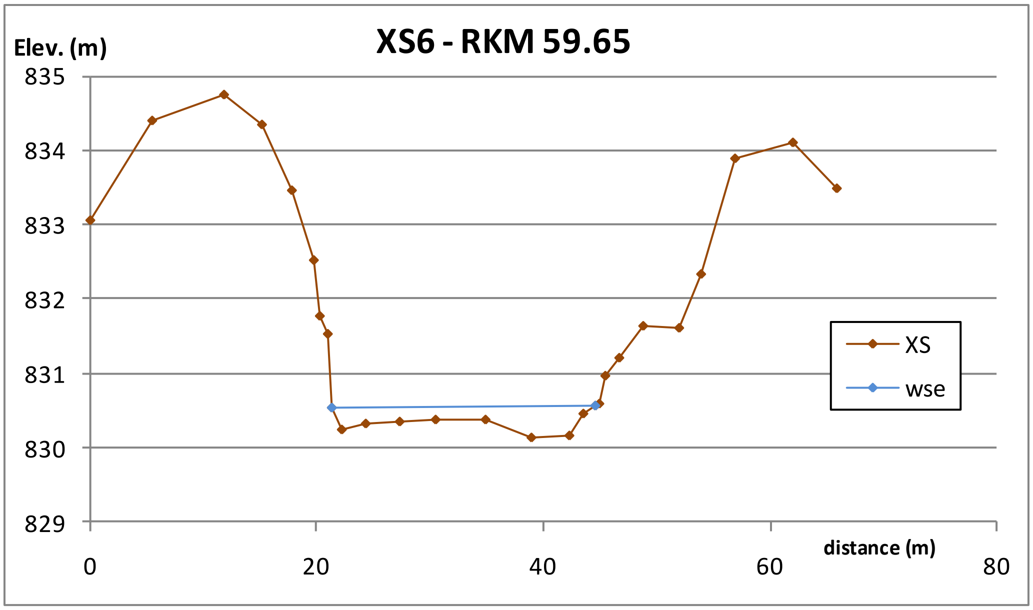
Graph 5 – XS3 at RKM 59.95



Graph 6 – XS4 at RKM 59.9



Graph 7 – XS5 at RKM 59.75



Graph 8 – XS5 at RKM 59.65

X-Section	RKM	Left Bank Height	Right Bank Height	Thalweg to Left Bank	Thalweg to Right Bank	Left Bank to Right Bank
1	60.2	3.6	3.9	35.7	23.4	59.1
2	60.1	4.6	4.7	6.9	39.1	46
3	59.95	4.2	4.2	47.2	11.3	58.5
4	59.9	4.4	4.3	11.9	30.8	42.7
5	59.75	4	3.7	26.8	10.7	37.5
6	59.65	3.6	4	29.6	12.1	41.7
Average		**4.1**	**4.1**			**47.6**

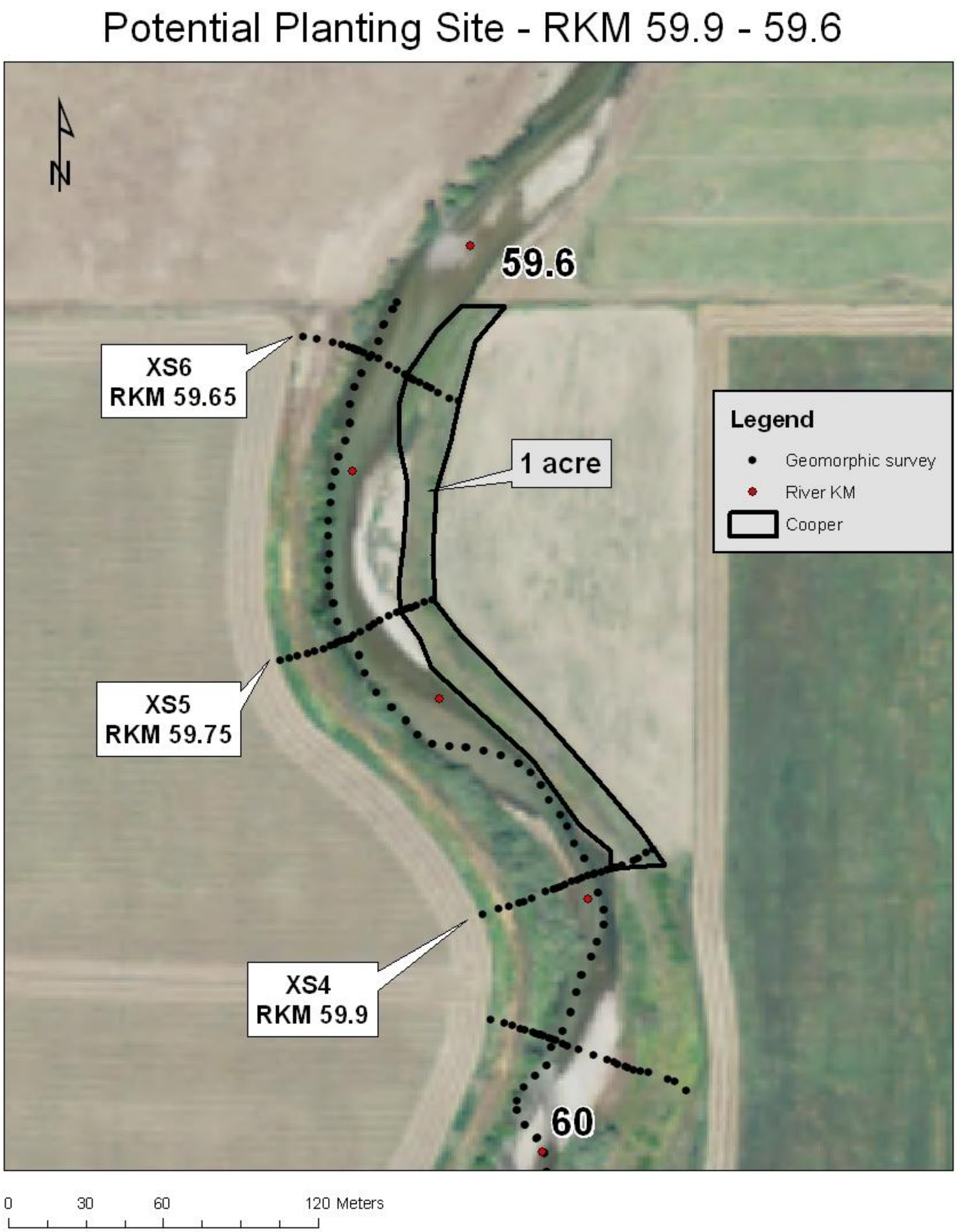
Table 2 – bank height and channel width (meters)

A comparison of the morphology of the Scott River using aerial images from 1993 and 2009 shows that the channel's structure has changed little. This is likely due to the constrained nature of the leveed channel. Within the confines of the stream banks movement of the channel's thalweg and the associated gravel bars can be seen.

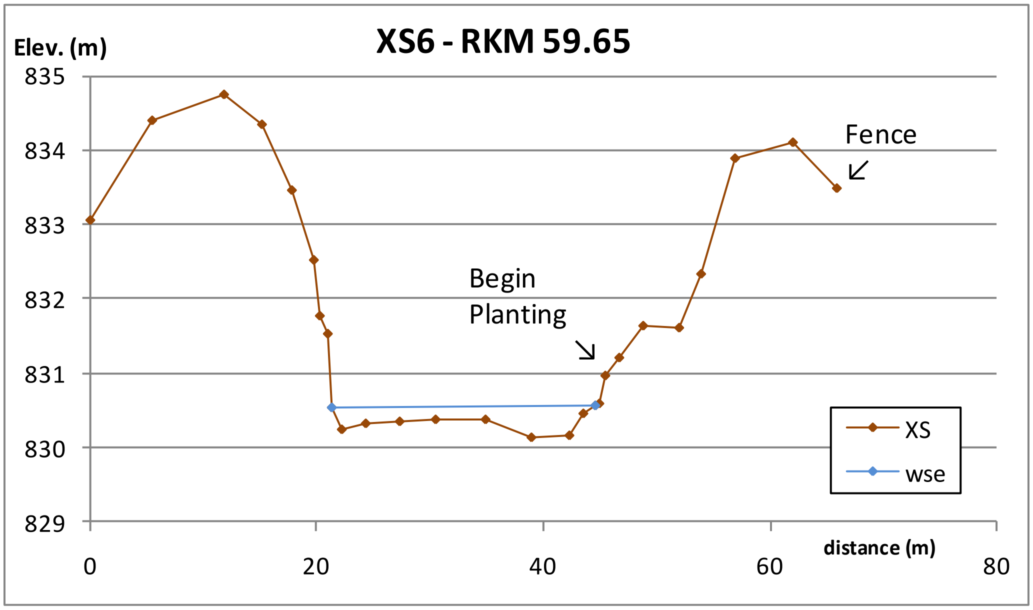
Map 2 – Scott River Morphology RKM 60.3 – 59.6 – 1993 & 2010

Potential Planting Sites

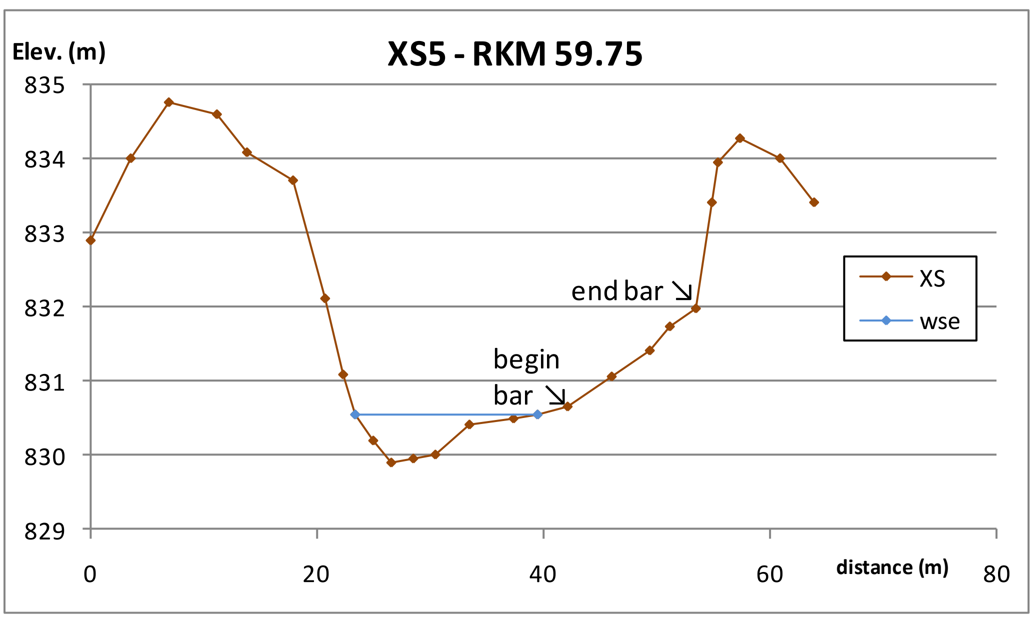
Two potential planting sites were identified using the geomorphic survey data presented above combined with vegetation height data that was calculated from the LIDAR data sets captured in 2010 (Map 6). The two sites are an acre strip on the east bank with very limited existing vegetation (Map 2) and a 0.8 acre strip on the west bank with limited vegetation (Map 3). Analysis of the elevations from the cross section data in these two plots will help direct the planning and design of planting efforts in these two potential locations.



Map 2 – Potential planting site on East Bank – RKM 59.9 – RKM 59.6

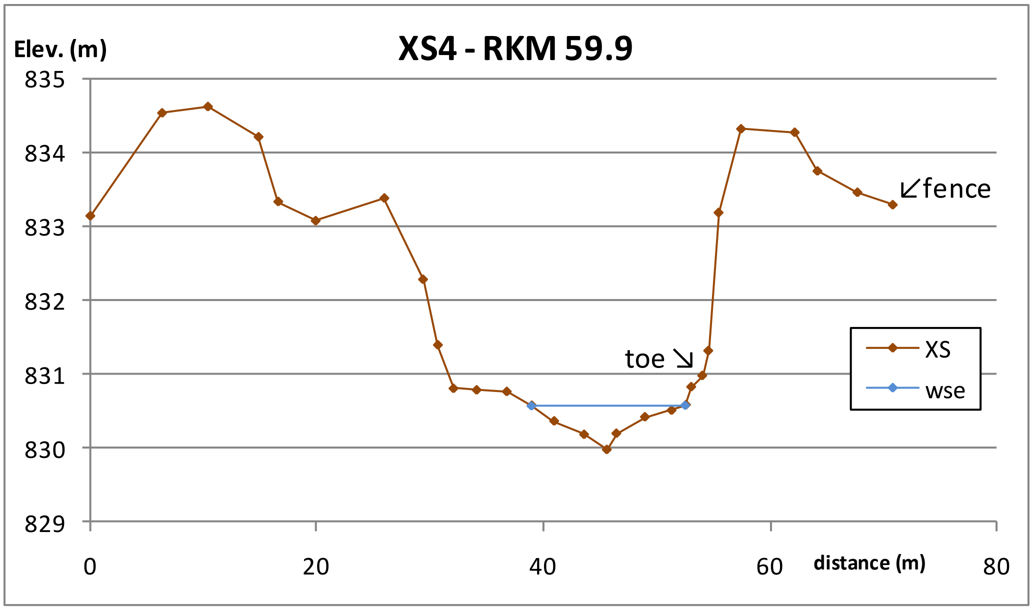


Graph 9 – XS6 – depicting potential planting site on right bank



Graph 10 – XS5 - depicting potential planting site on right bank

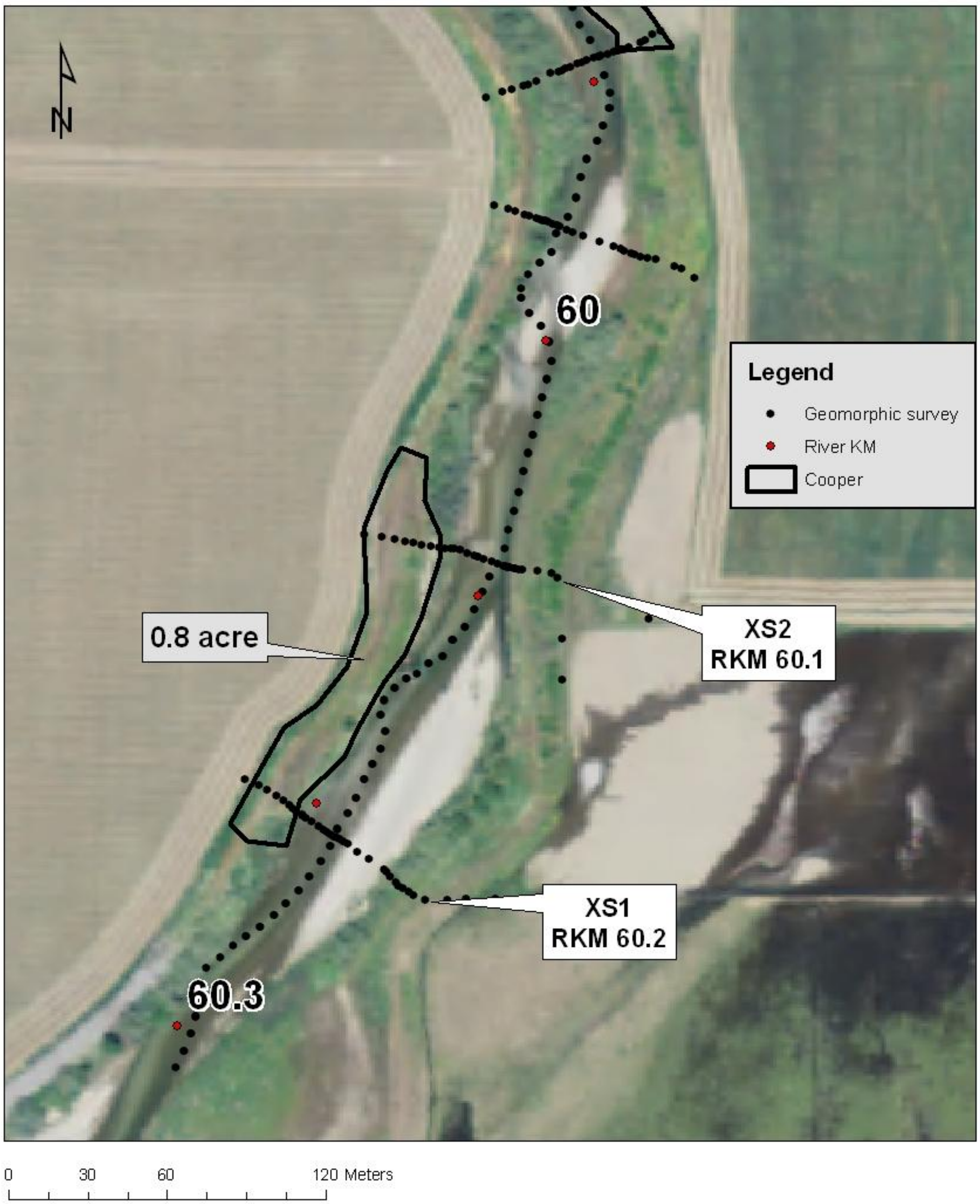
A gravel bar at river right RKM 59.7 – RKM 59.8 was captured in XS5 (Graph 10). This bar is approximately 10 meters wide with an increase in elevation of 1.4 meters. The upslope portion of the bar is a potential site for planting of riparian cuttings (e.g. willow) using bio-engineering techniques.



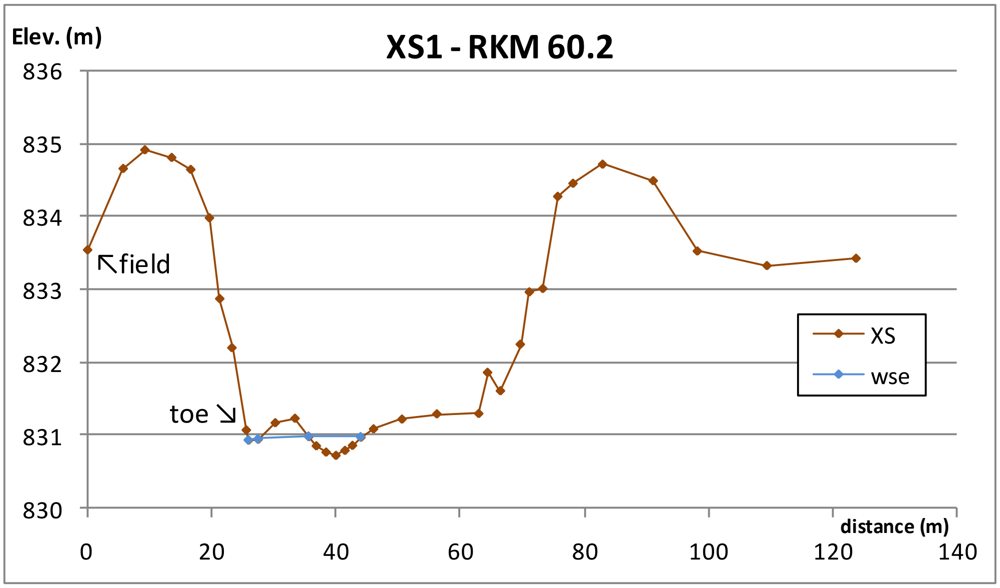
Graph 11 – XS4 – depicting potential planting site on right bank

The average height from the base flow water surface elevation to the top of the bank in the east bank planting site is 4 meters. The average height from the top of bank to the adjacent fence and field is approximately 0.7 meters. There is existing riparian vegetation upstream from the proposed planting site indicating a high potential for success of vegetation in this location.

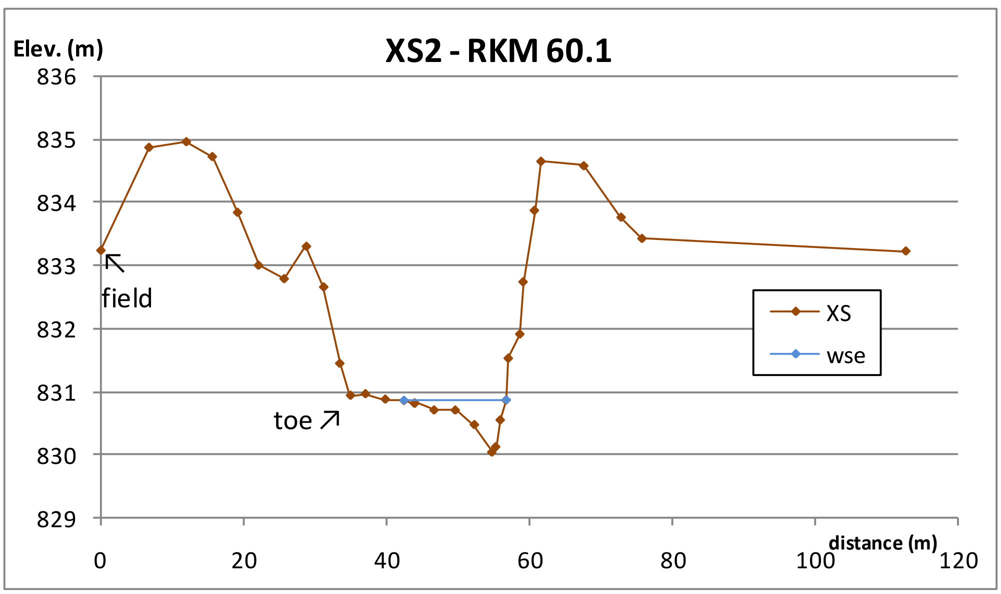
Potential Planting Site - RKM 60.2 - 60.1



Map 3 – Potential planting site – West bank – RKM 60.2 – RKM 60.1



Graph 12 – XS1 with the potential planting plot on left bank



Graph 13 – XS2 with the potential planting plot on left bank

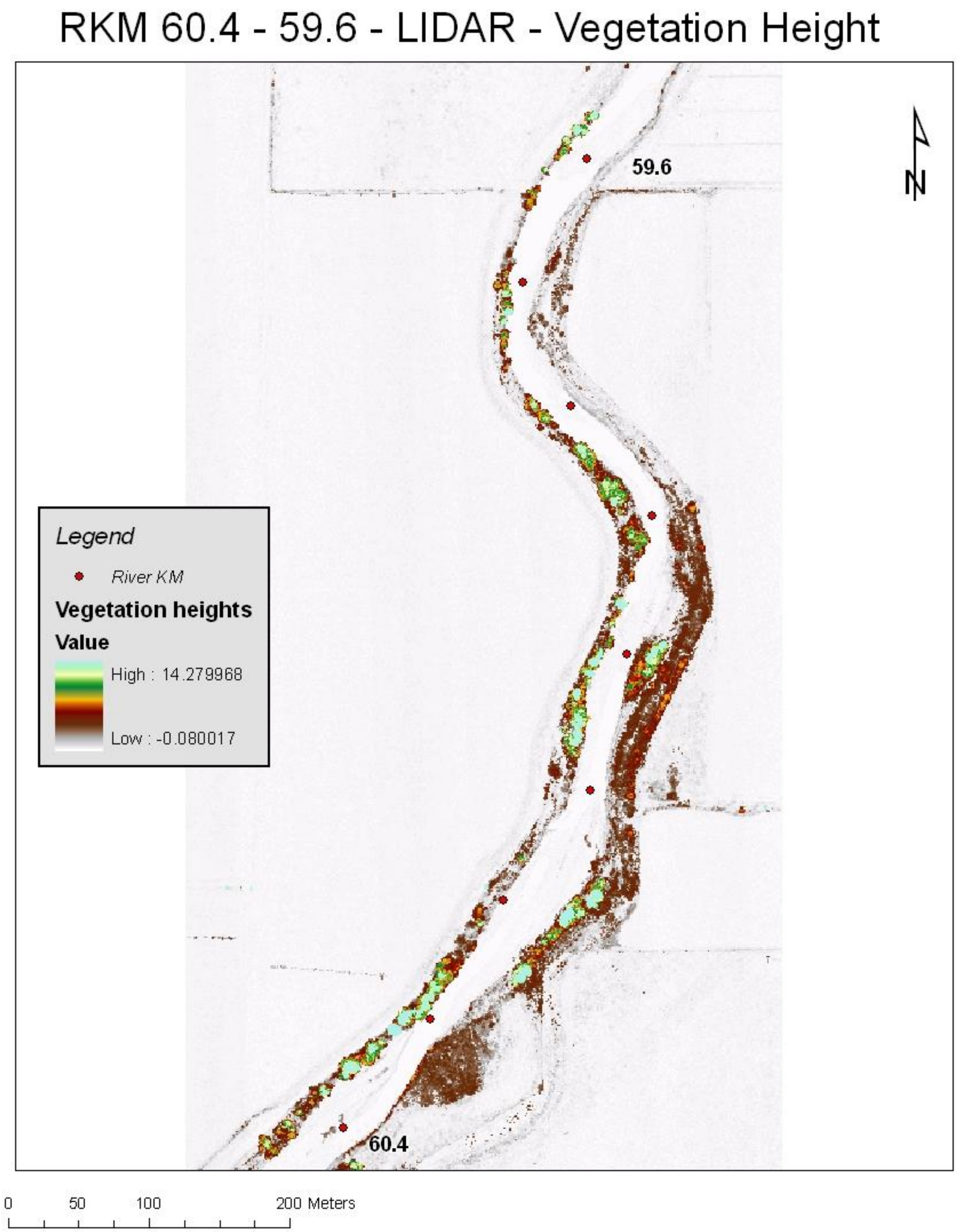
XS1 shows that the bank at the potential planting site is very steep with a top that is relatively flat for 10 -15 meters. The top of this bank is approximately 4 meters higher than the base flow water surface elevations in the stream but only 1.5 meters higher than adjacent field elevations. It is hypothesized that the water table during the summer months is between 2 to 4 meters below the top of bank. The downstream cross section (XS2) shows a wider and more gradually sloped bank. This cross section is adjacent to an area on the bank with existing vegetation indication the potential for success. The 10 meters of this bank adjacent to the stream bed is 2 meters or less higher than the base flow water surface elevation with the rest of the bank rising to 4 meters above base flow water.

RKM 60.4 - 59.6 - NAIP 2010

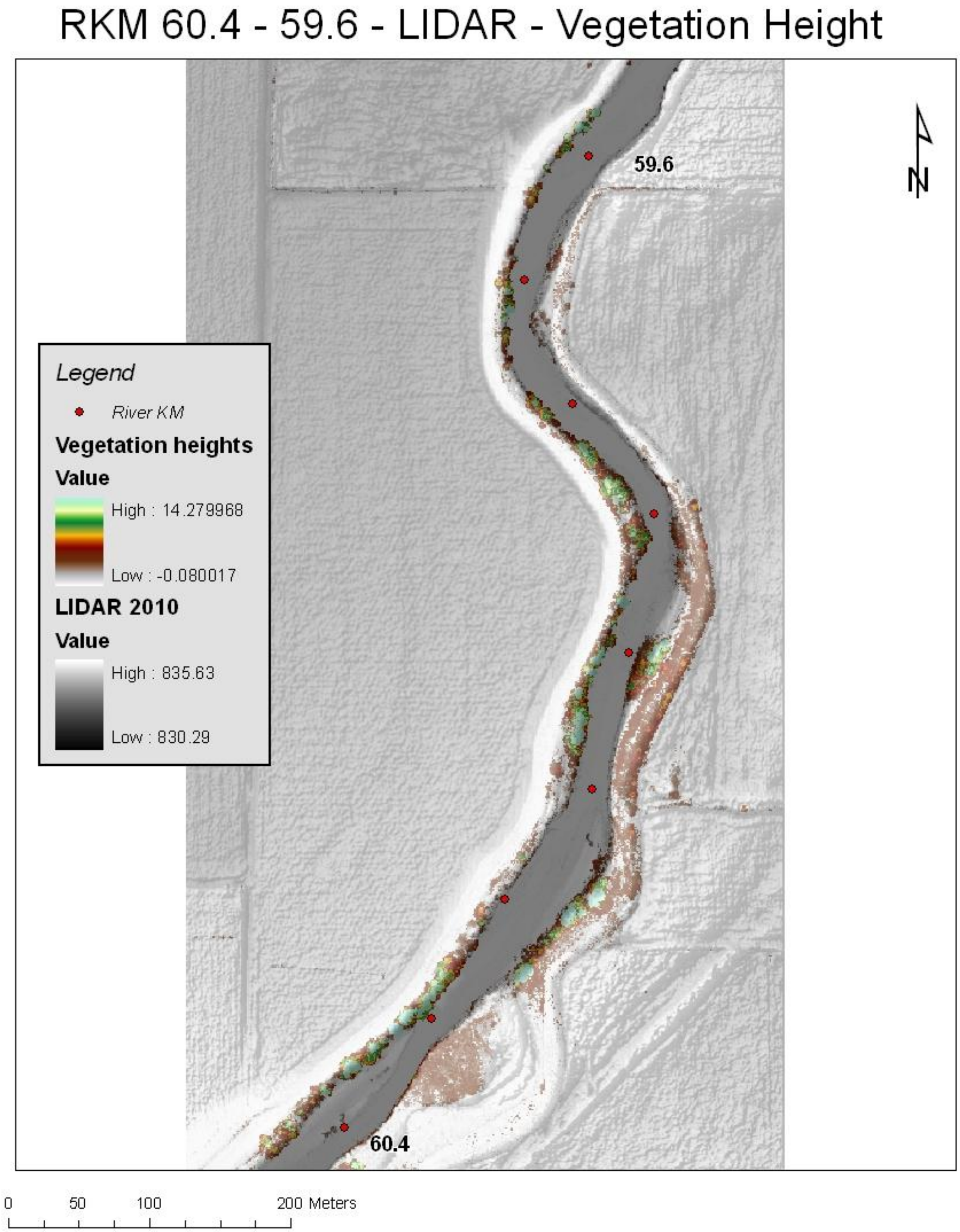
Map 4 – 2010 NAIP imagery of reach

RKM 60.4 - 59.6 - LIDAR - Bare Earth

Map 5 – Bare earth elevations from LIDAR

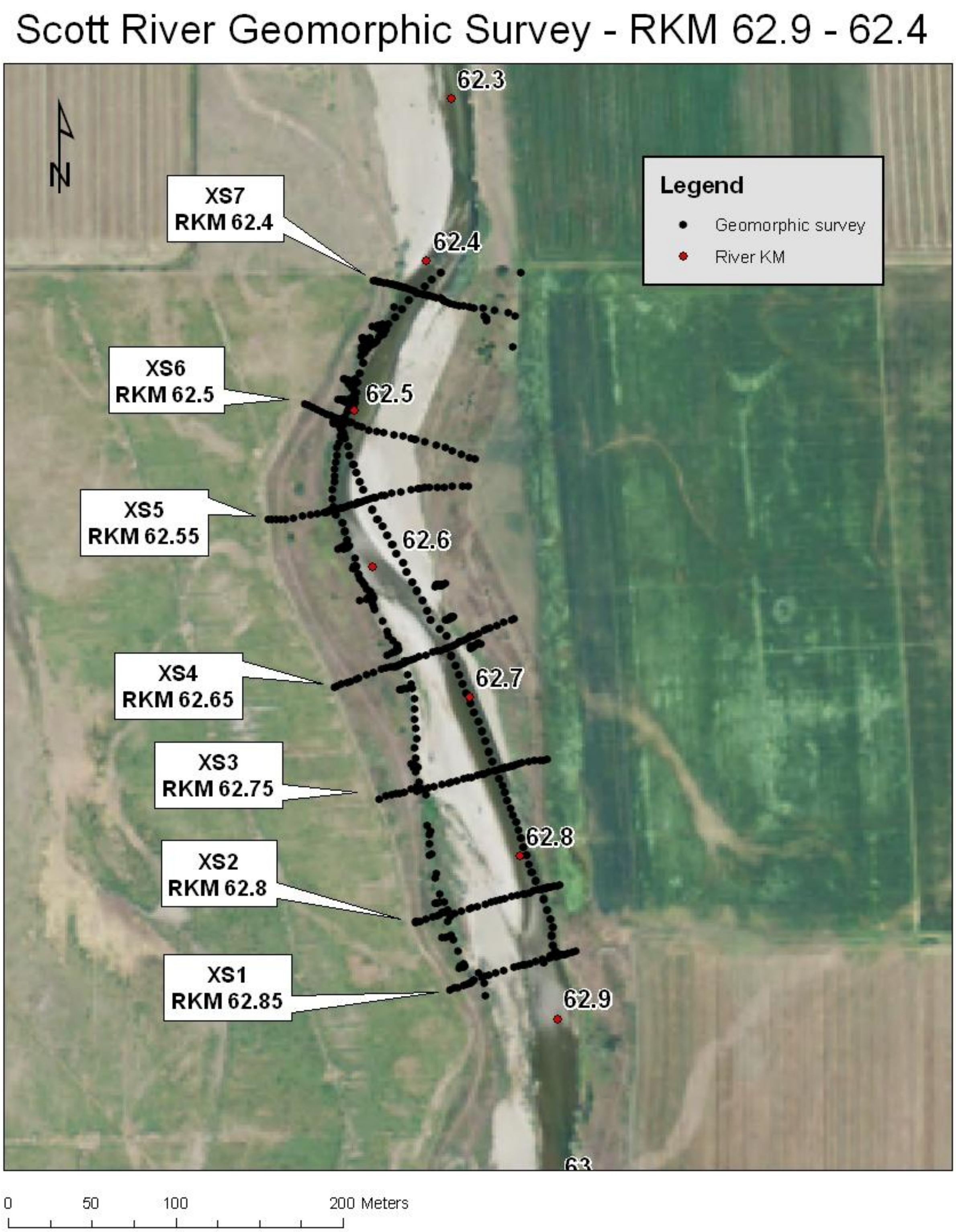


Map 6 – Vegetation heights from LIDAR data sets

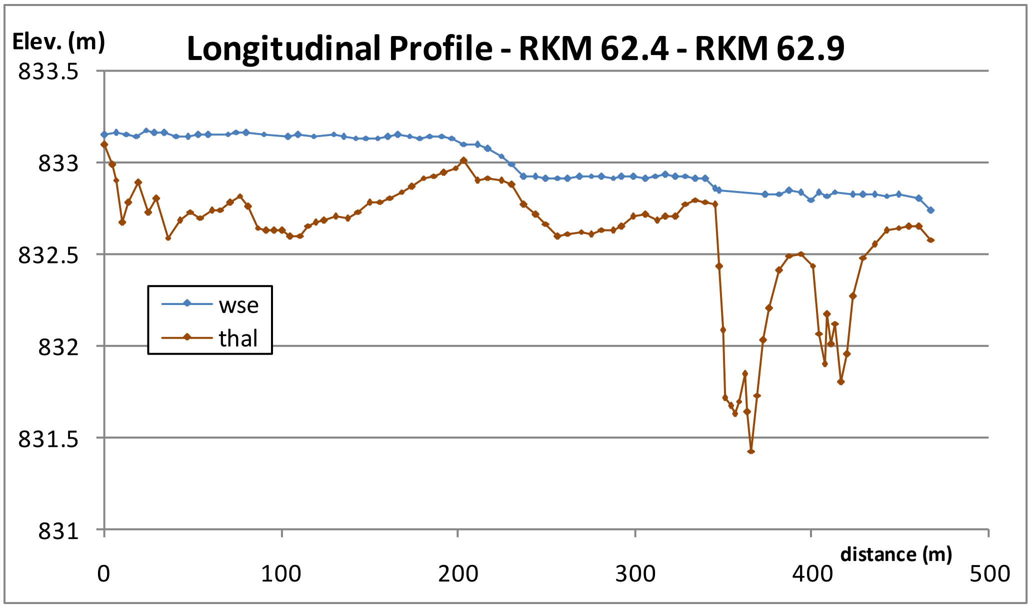


Map 7 – Vegetation heights and bare earth elevations from LIDAR data sets

RKM 62.4 – RKM 62.85 - Black Ranch

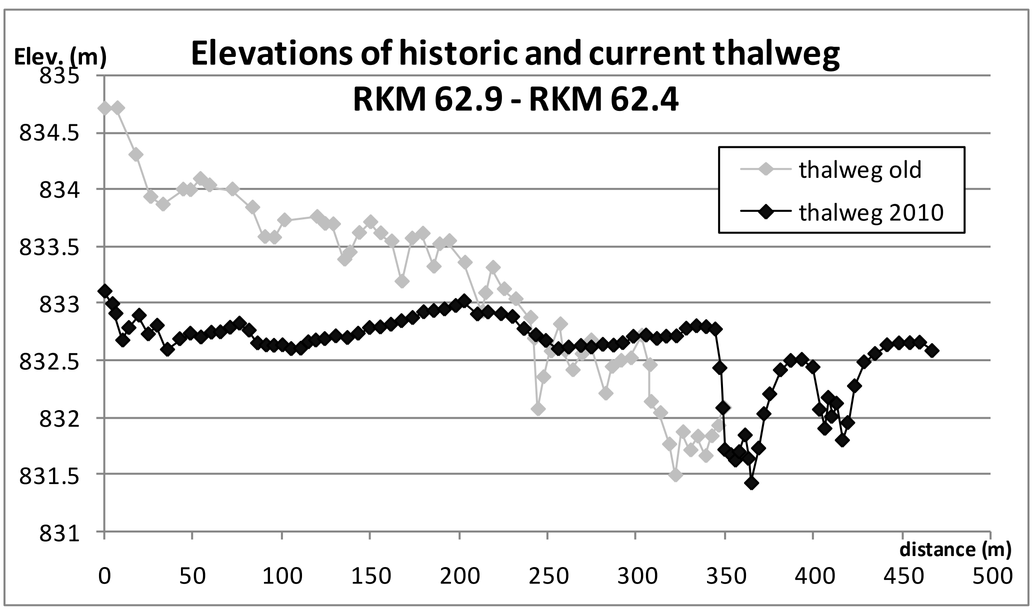


Map 1 – Surveyed reach – RKM 62.4 – RKM 62.9



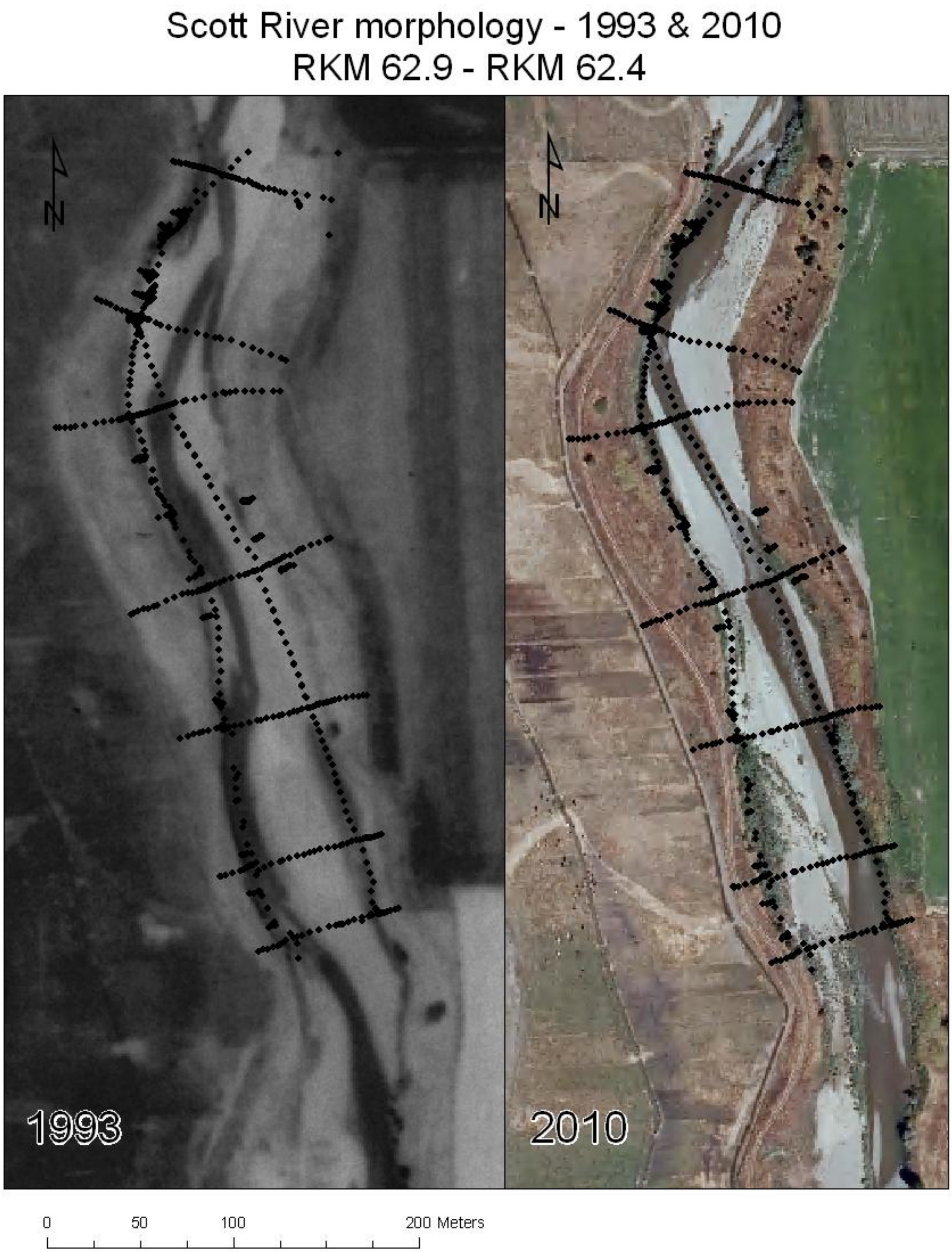
Graph 1 – Longitudinal profile and water surface elevation

Stream gradient is approximately 0.1% through the reach.



Graph 2 – Current and historic longitudinal profile

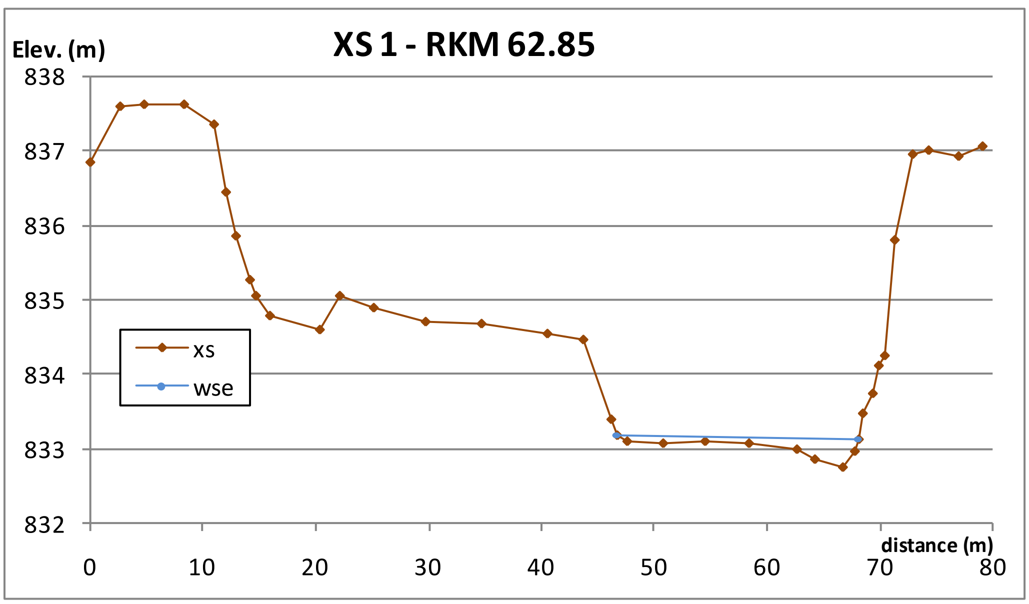
A historic channel thalweg was surveyed on river left. The slope of the surveyed historic channel is approximately 0.7% significantly steeper than the current channel gradient.



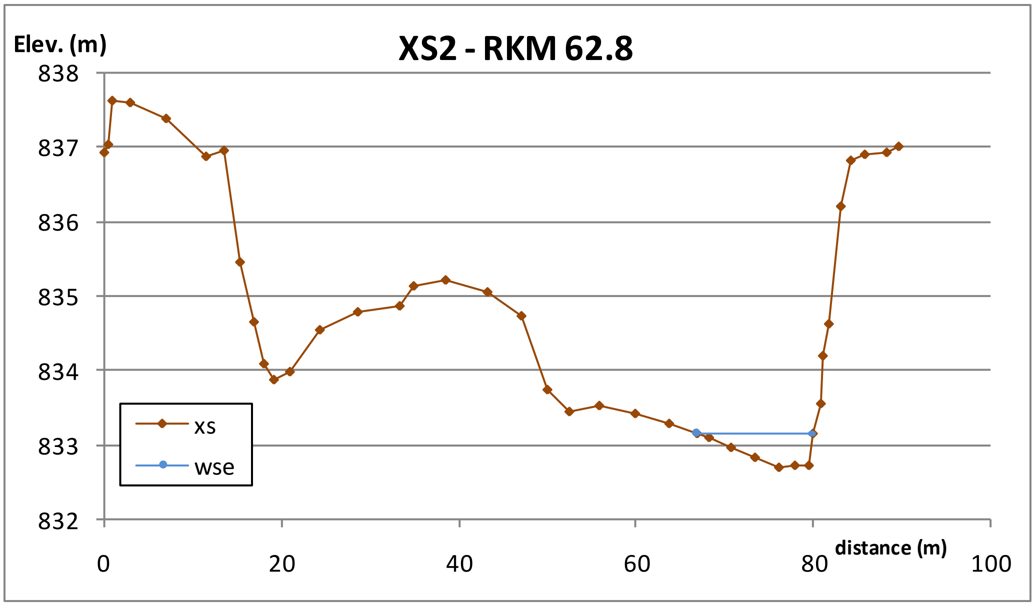
Map 2 – Surveyed reach – aerial images from 1993 and 2010

Stream KM	Potential Shade	Current Shade	Potential Shade Increase
62.9	0.23	0.02	0.21
62.8	0.22	0.03	0.19
62.7	0.24	0.02	0.22
62.6	0.34	0.03	0.31
62.5	0.24	0.02	0.22
62.4	0.17	0.02	0.15

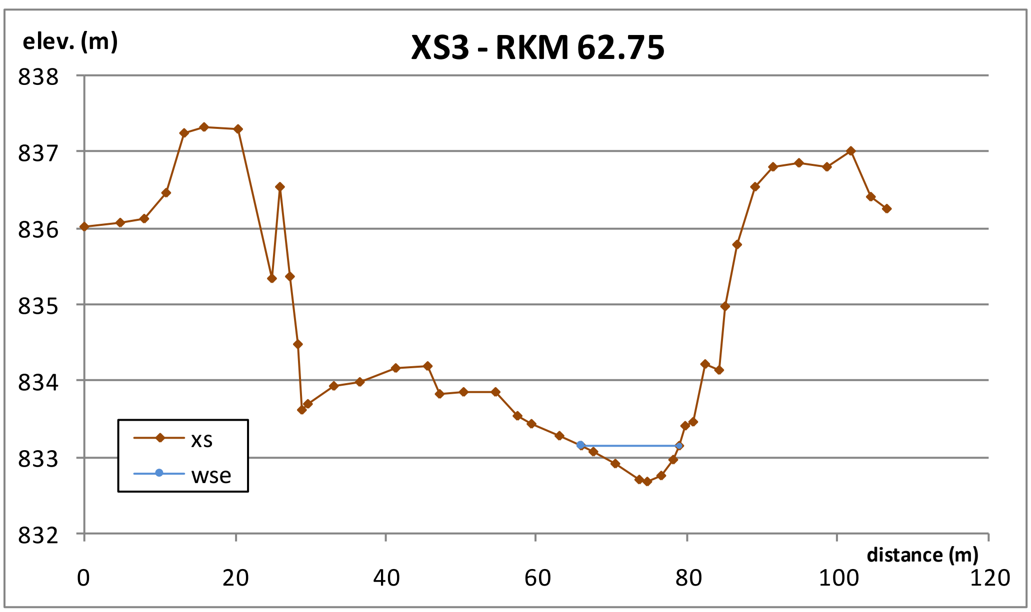
Table 1 – Potential and current shade from NCRWQCB Staff Report for Scott River TMDL



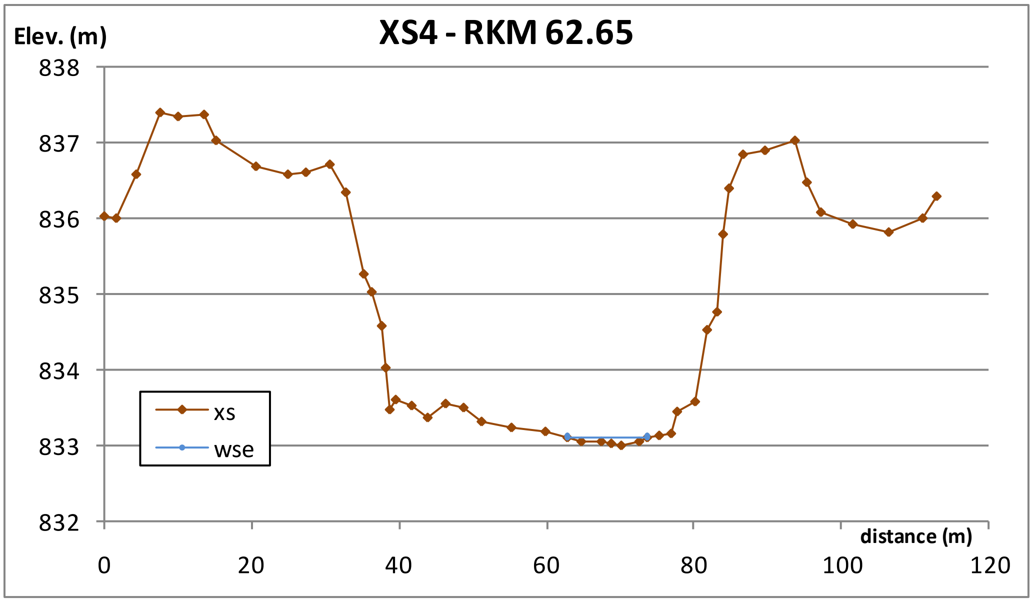
Graph 3 – XS1 at RKM 62.85



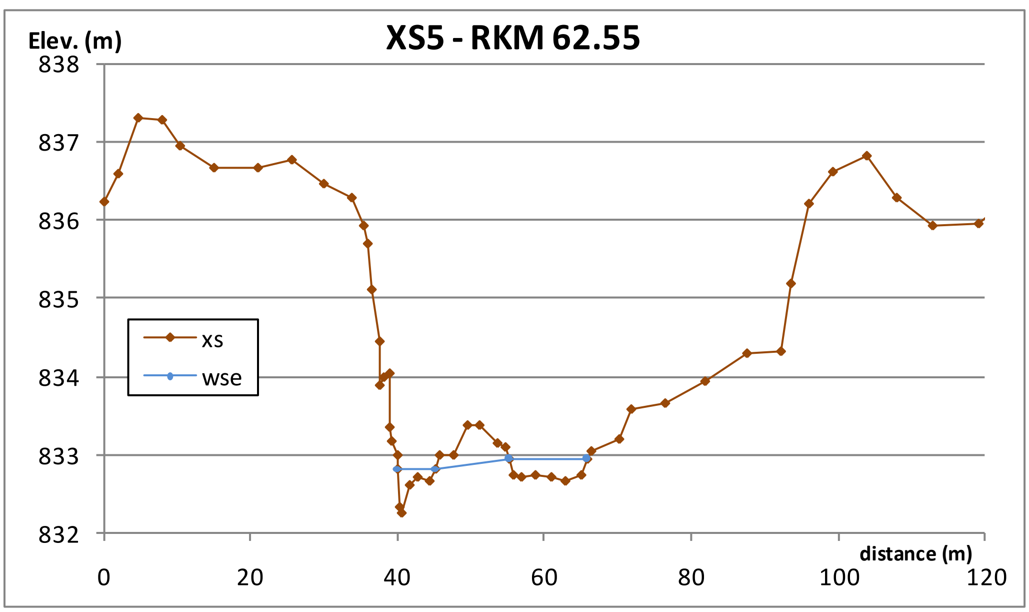
Graph 4 – XS2 at RKM 62.8



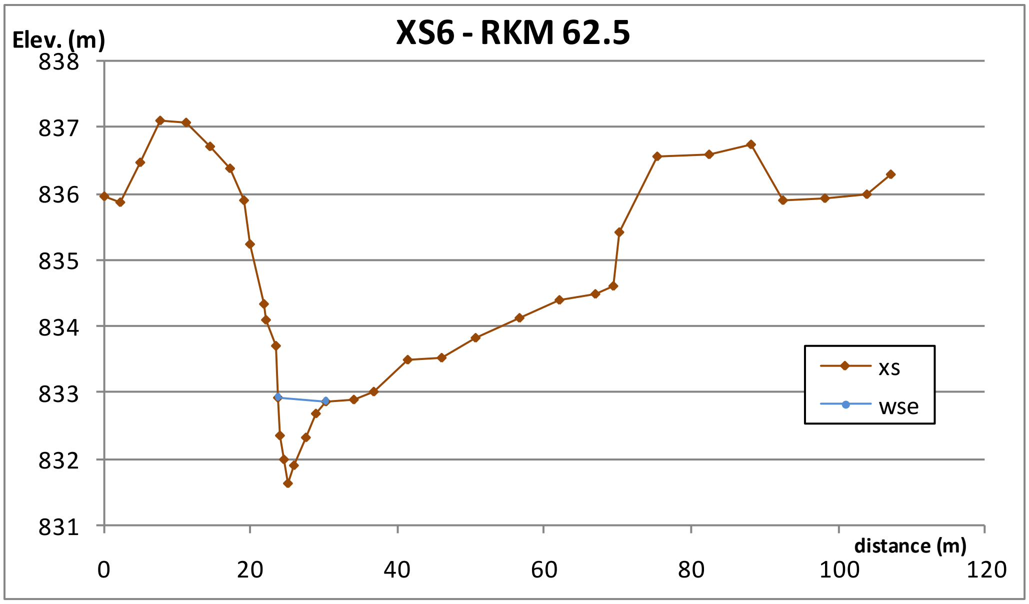
Graph 5 – XS3 at RKM 62.75



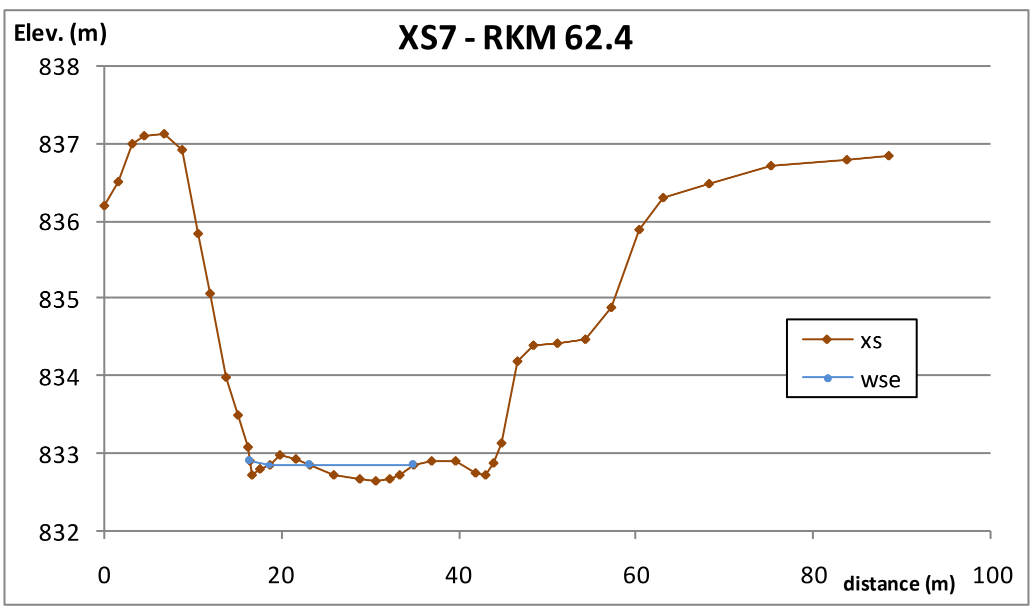
Graph 6 – XS4 at RKM 62.65



Graph 7 – XS5 at RKM 62.55



Graph 7 – XS6 at RKM 62.5



Graph 8 – XS7 at RKM 62.4

X-Section	RKM	Left Bank Height	Right Bank Height	Thalweg to Left Bank	Thalweg to Right Bank	Left Bank to Right Bank
1	62.85	4.4	4	51	10.2	61.2
2	62.8	4.2	4.1	64.4	6.2	70.6
3	62.75	4.6	4.1	54.2	16.6	70.8
4	62.65	3.3	3.8	35.8	18	53.8
5	62.55	3.6	3.5	27	35.3	62.3
6	62.5	5.4	4.9	13.7	50.3	64
7	62.4	4.3	3.7	21.9	32.4	54.3
Average		**4.3**	**4.0**			**62.4**

Table 2 – Bank height and channel width (meters)

The distance from the river's thalweg to the top of the right and left bank was calculated for each cross section (Table 2). The left bank was 4.3 meters (14.1 ft) from thalweg to top of bank and the right bank was 4.0 meters (13 ft) from thalweg to top. There are two large gravel bars and terraces in the surveyed reach that offer relatively flat surfaces for potential riparian re vegetation that are below the elevation of the top of bank. These bars and terraces include – river left XS1 – XS4 and river right XS5 – XS7.

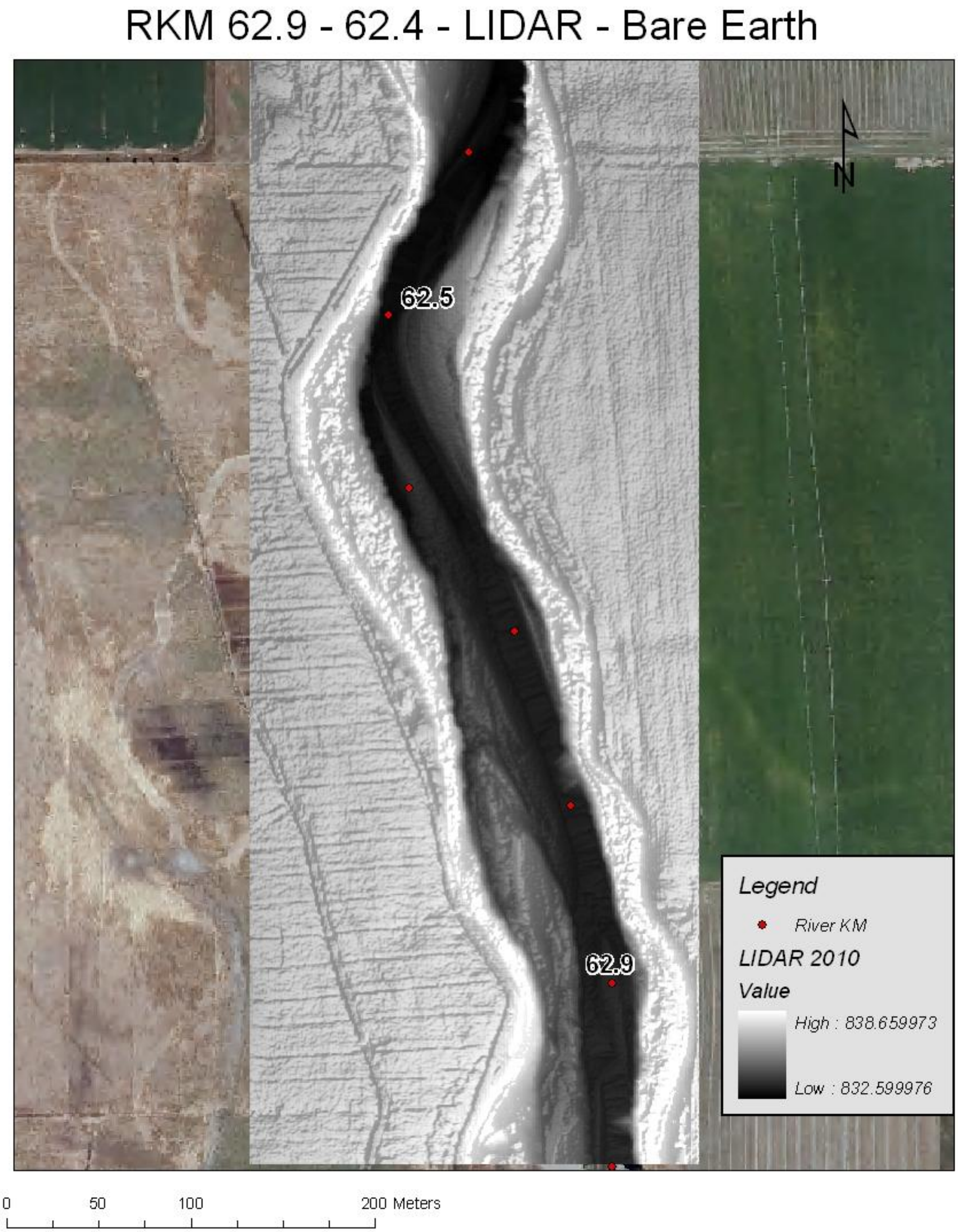
Several rock deflectors in the reach were surveyed (Map 3). Additionally, several log piers were found and surveyed in the historic channel.

Scott River Geomorphic Survey - RKM 62.9 - 62.4

Map 3 – Rock deflectors and historic wooden piers in survey reach

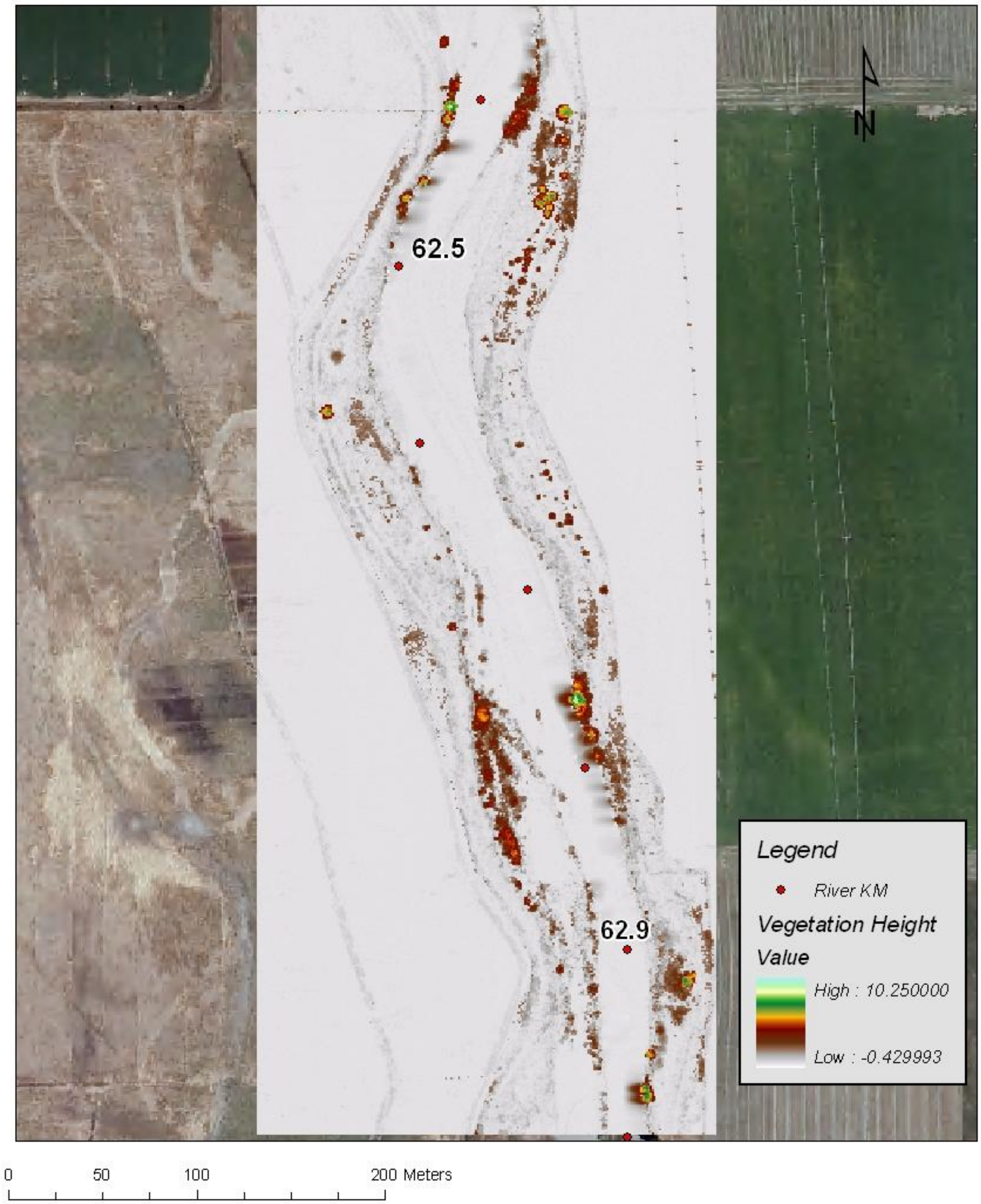
RKM 62.9 - 62.4 - NAIP - 2010

Map 4 – NAIP aerial imagery - 2010



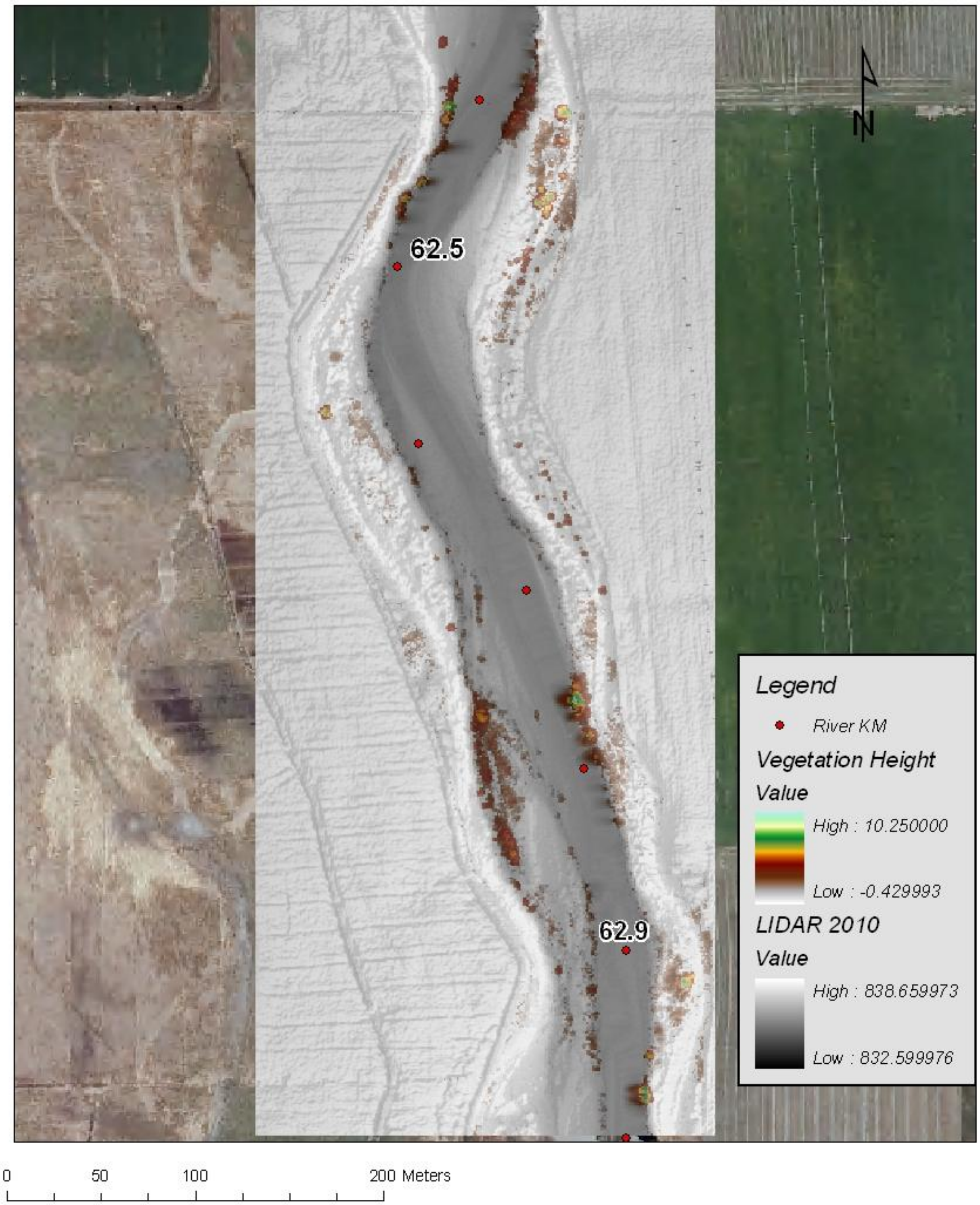
Map 5 – Lidar imagery of the bare earth

RKM 62.9 - 62.4 - LIDAR - Vegetation Height



Map 6 – Calculated vegetation height from Lidar imagery

RKM 62.9 - 62.4 - LIDAR - Vegetation Height

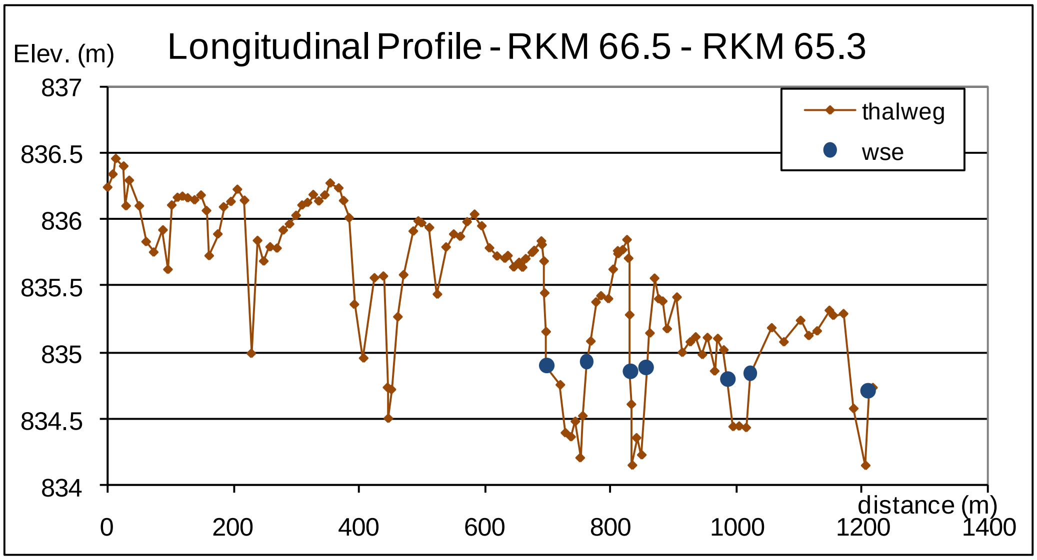


Map 7 – Vegetation height and bare earth elevation

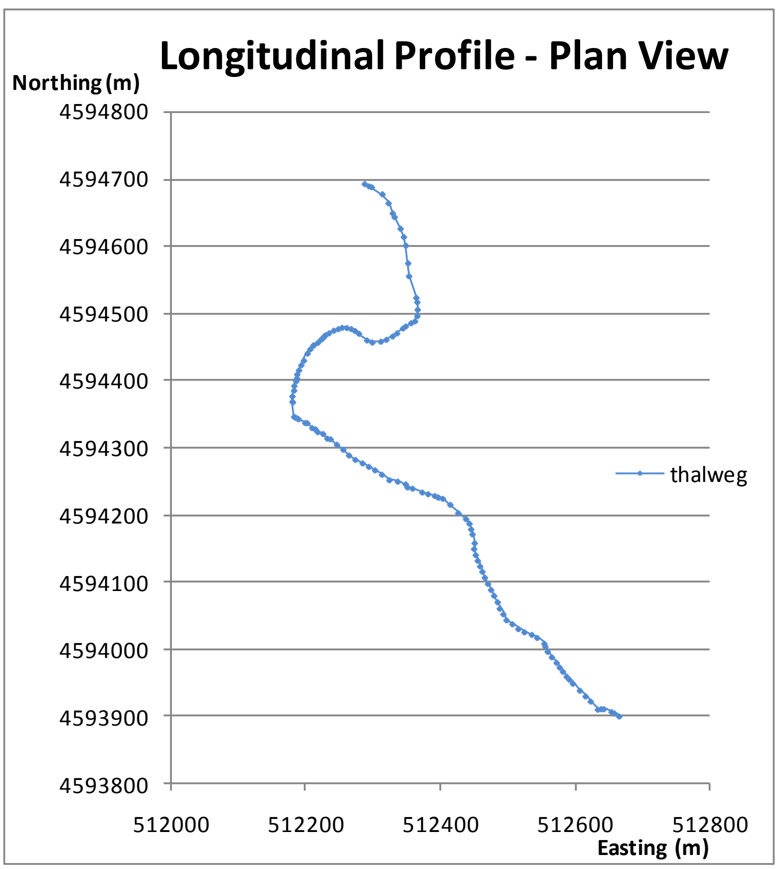
Reach III. Stream Channel Cross Section Data

Stream Channel cross section data and longitudinal profiles were collected by the Siskiyou RCD in the summer of 2010. The surveyed reach was approximately 0.12% in slope.

RKM 66.5 – 65.3 – Bryan-Morris Ranch

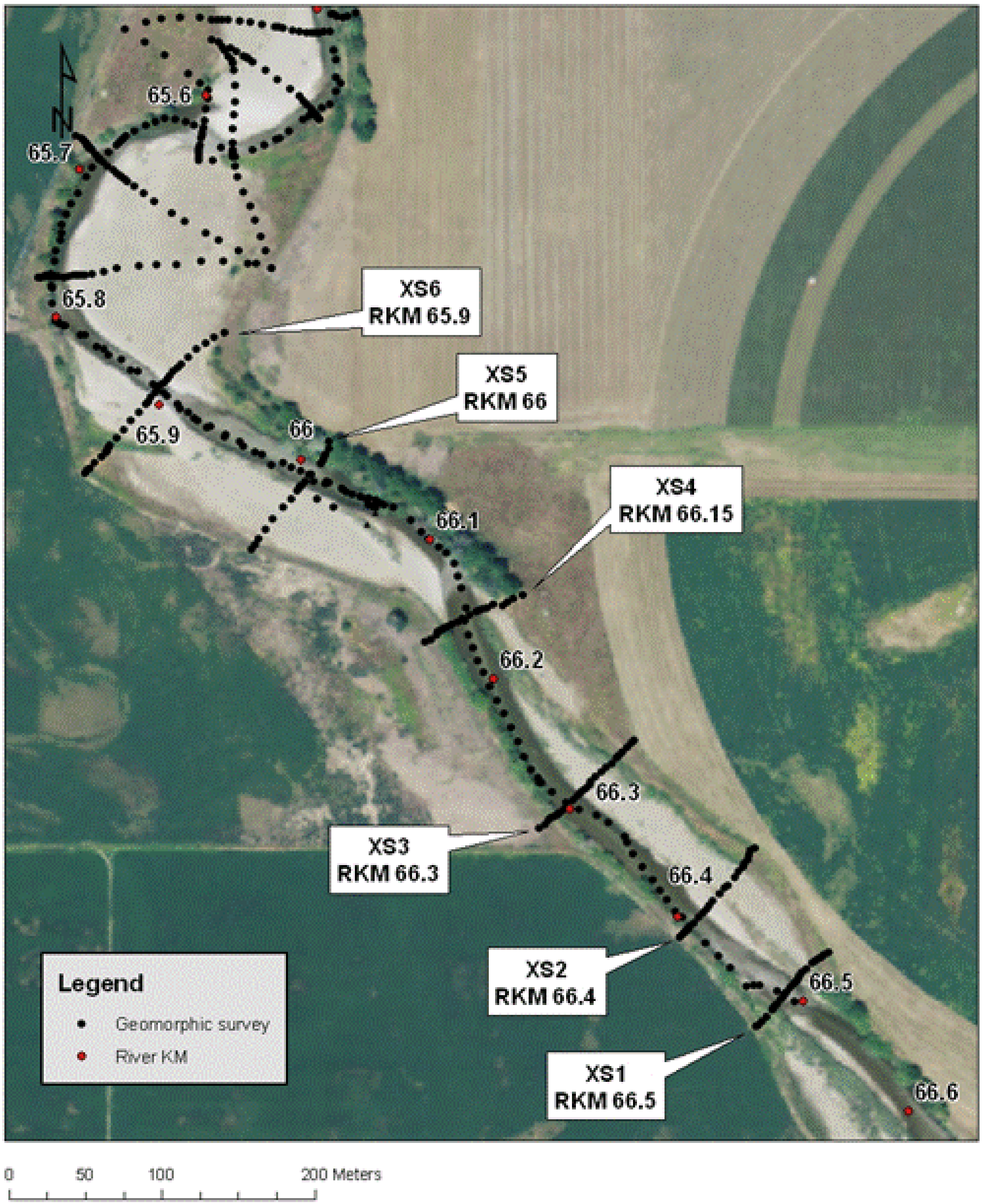


Graph 1 - Longitudinal profile of the Scott River thalweg – RKM 66.5 – 65.3



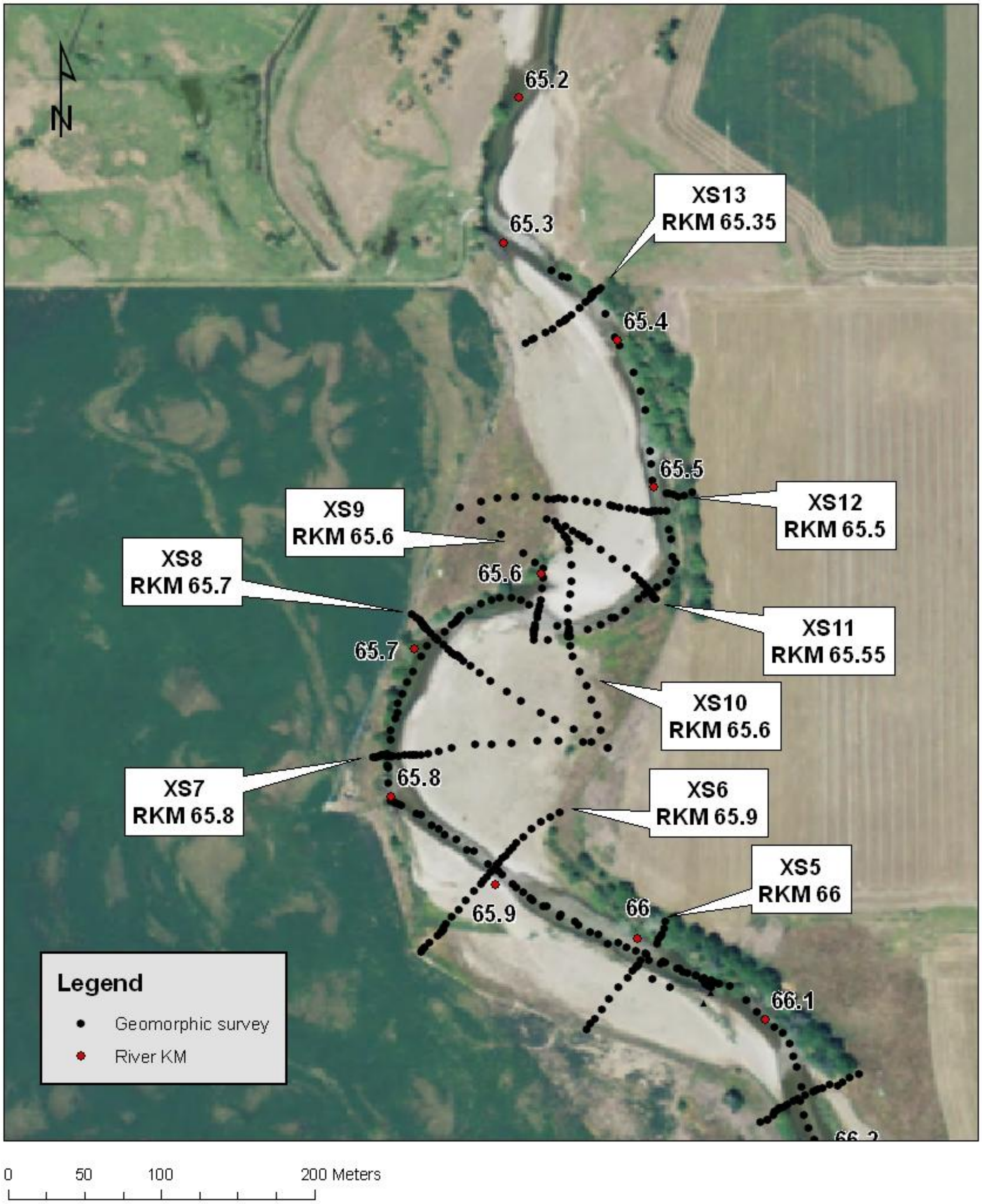
Graph 2 – Plan View of Longitudinal profile

Scott River Geomorphic Survey - RKM 66.5 - 65.3



Map 1 – up stream portion of surveyed reach – RKM 66.5 – RKM 65.3

Scott River Geomorphic Survey - RKM 66.5 - 65.3

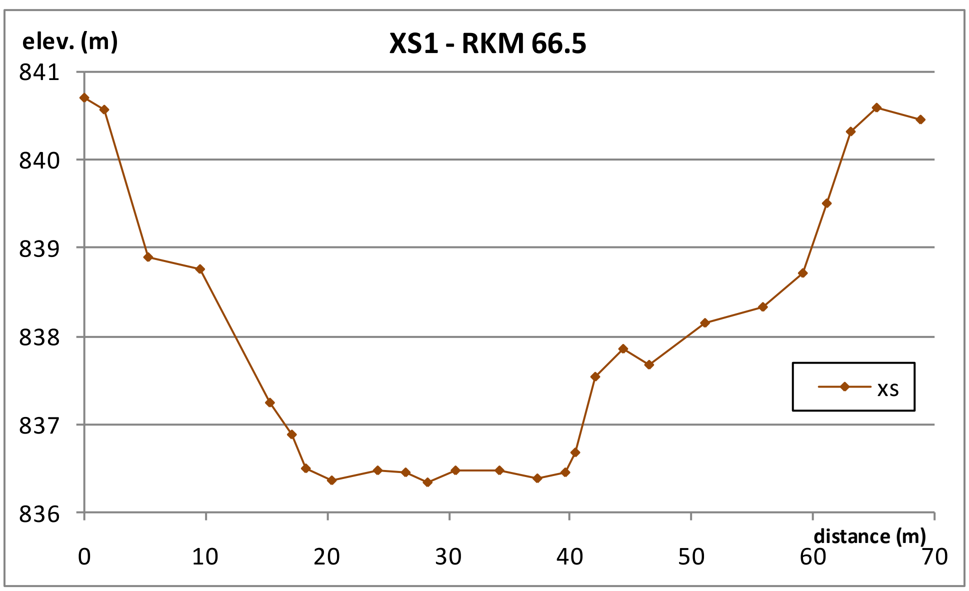


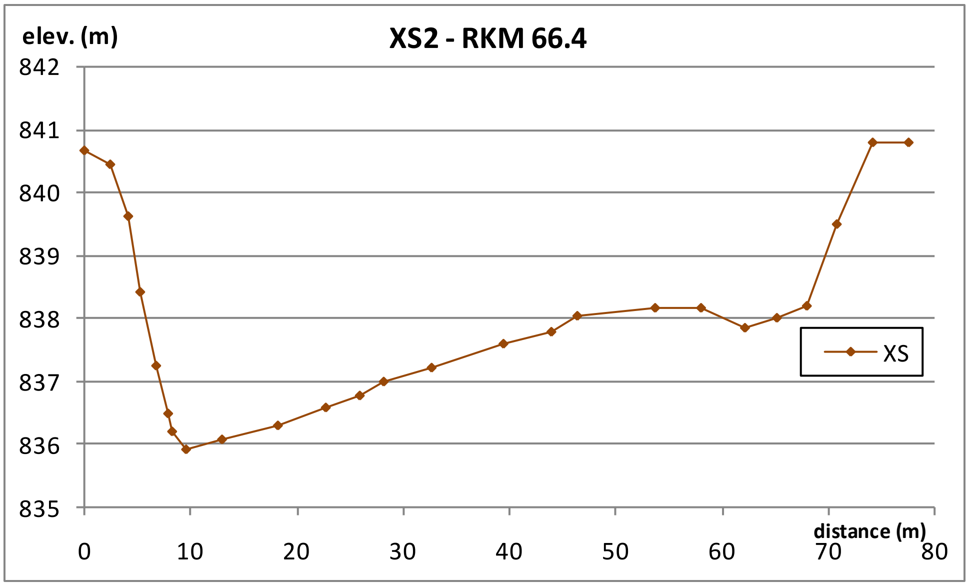
Map 2 – downstream portion of surveyed reach – RKM 66.5 – 65.3

Table 1 - Potential and current shade from NCRWQCB Staff Report for Scott River TMDL

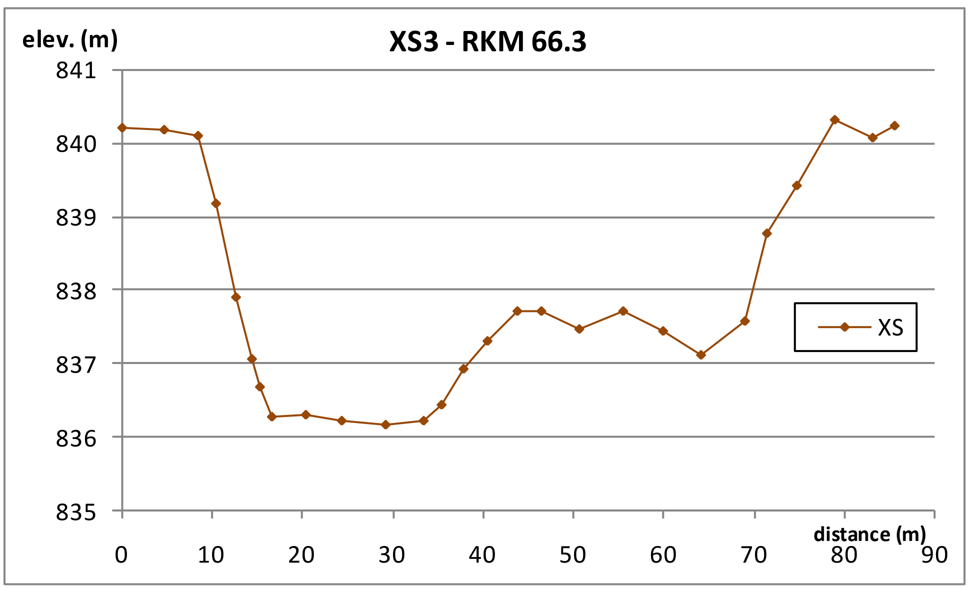
Stream KM	Potential Shade	Current Shade	Potential Shade Increase
66.5	0.25	0.01	0.24
66.4	0.3	0.02	0.28
66.3	0.3	0.02	0.28
66.2	0.55	0.08	0.47
66.1	0.22	0.23	-0.01
66	0.14	0.1	0.04
65.9	0.04	0.02	0.02
65.8	0.36	0.03	0.33
65.7	0.22	0.02	0.2
65.6	0.14	0.02	0.12
65.5	0.36	0.29	0.07
65.4	0.36	0.29	0.07
65.3	0.47	0.04	0.43

Graph 3 – XS1 at RKM 66.5

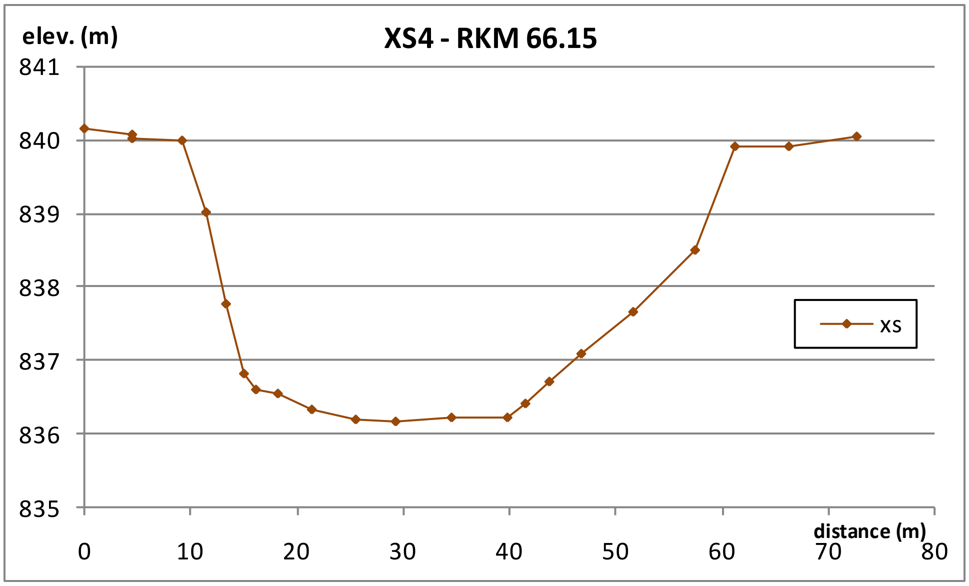




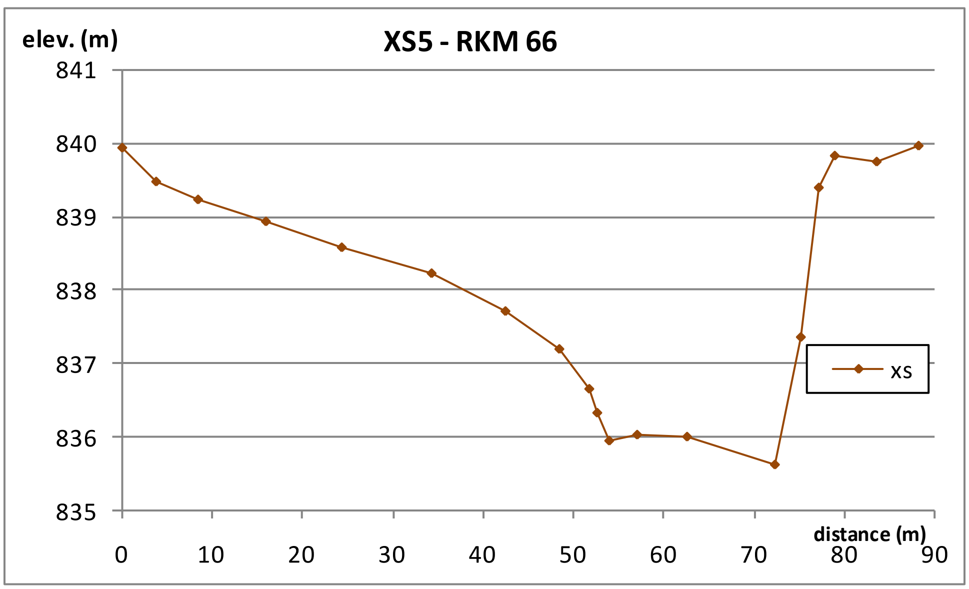
Graph 4 – XS2 at RKM 66.4



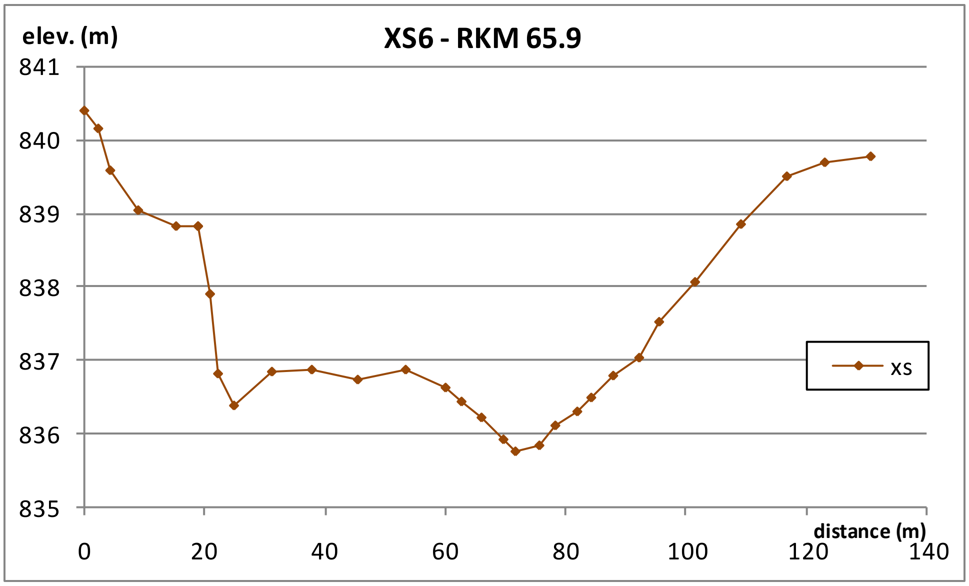
Graph 5 – XS3 at RKM 66.3



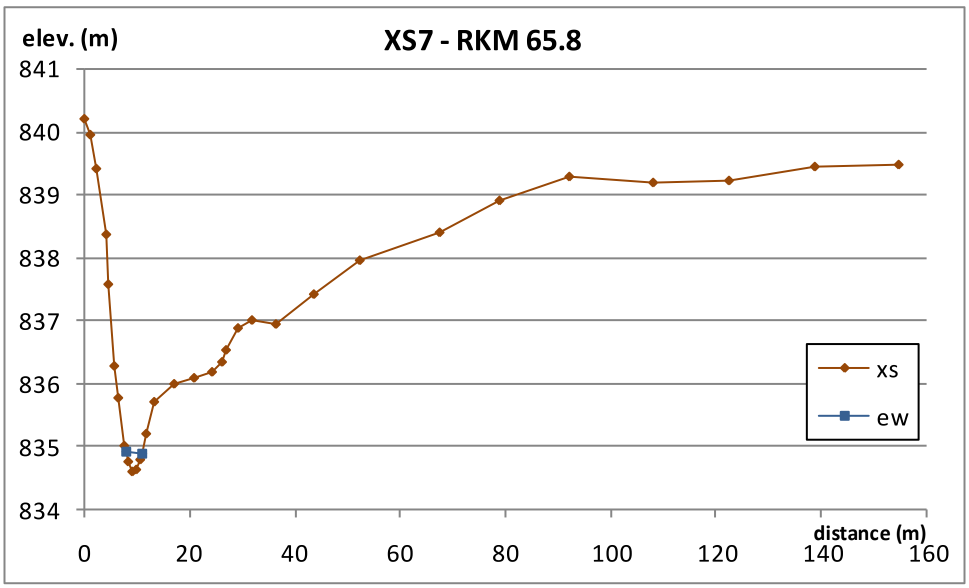
Graph 6 – XS4 at RKM 66.15



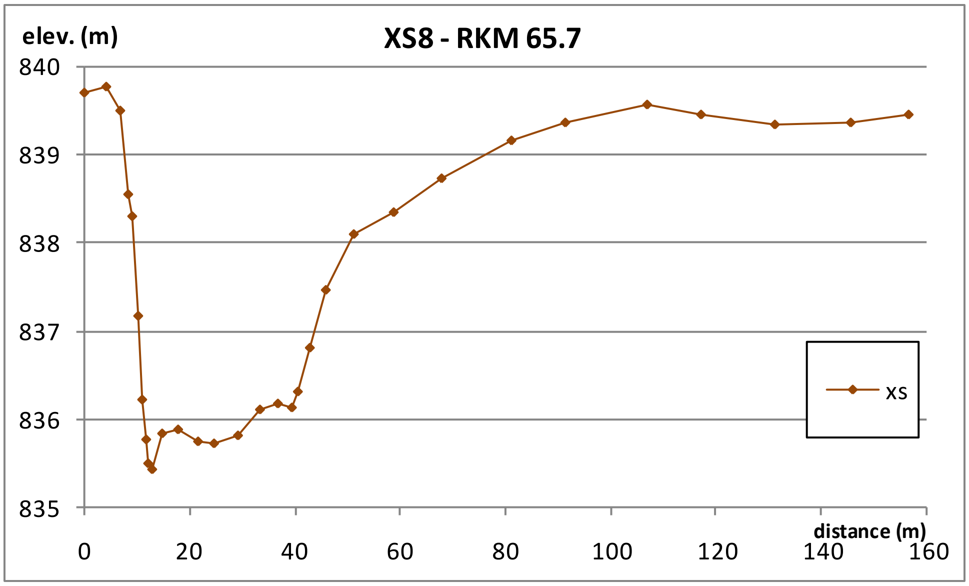
Graph 7 – XS5 at RKM 66



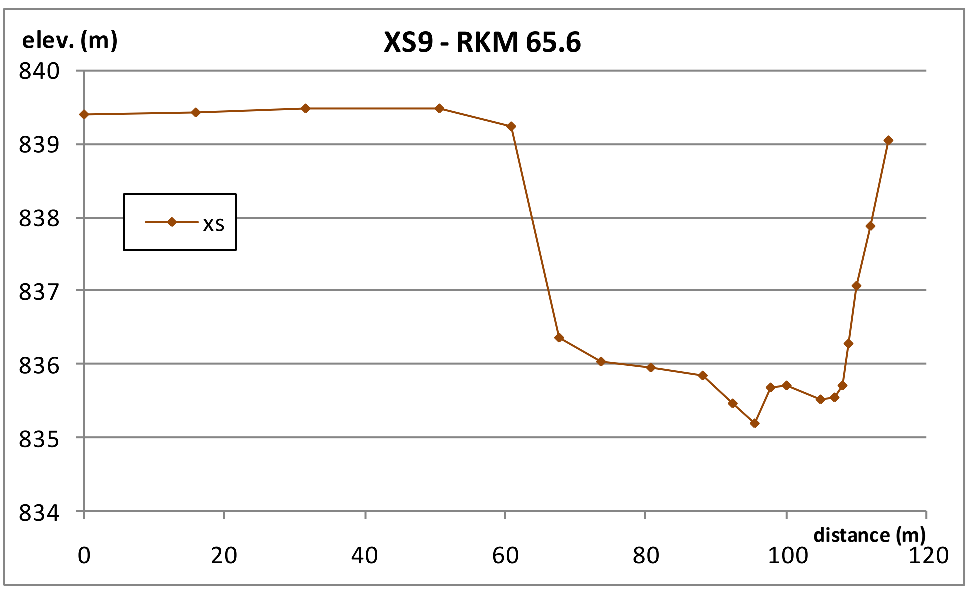
Graph 8 – XS6 at RKM 65.9



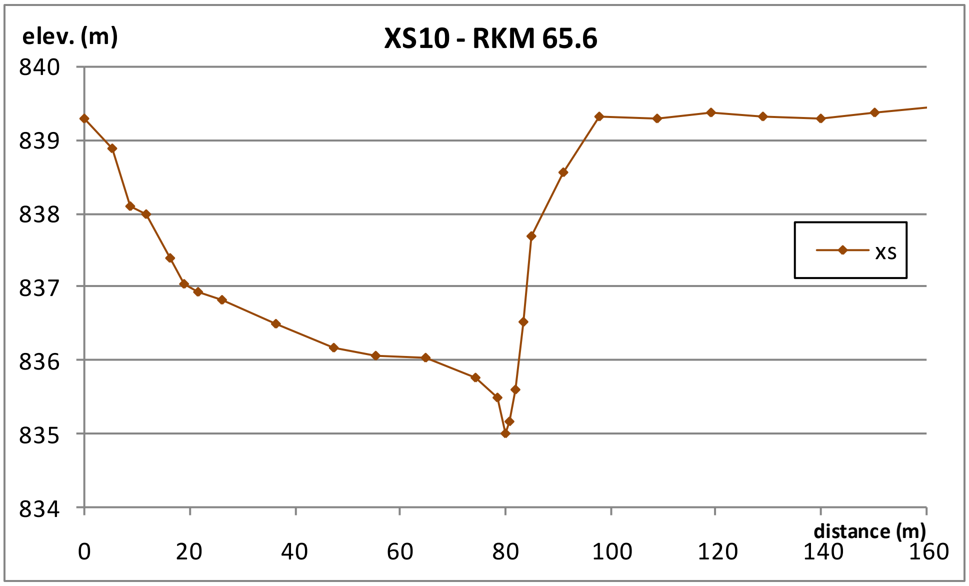
Graph 9 – XS7 at RKM 65.8



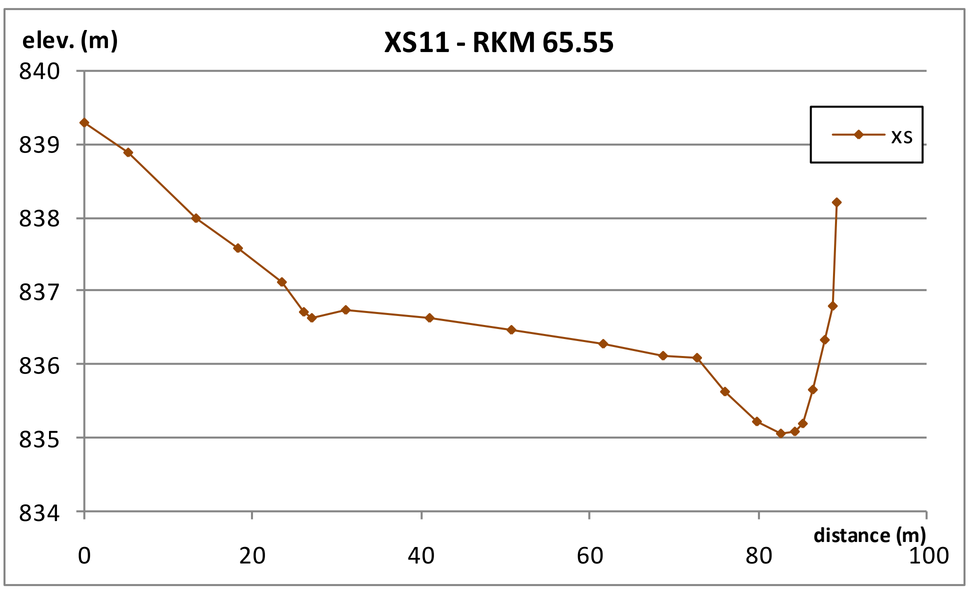
Graph 10 – XS8 at RKM 65.7



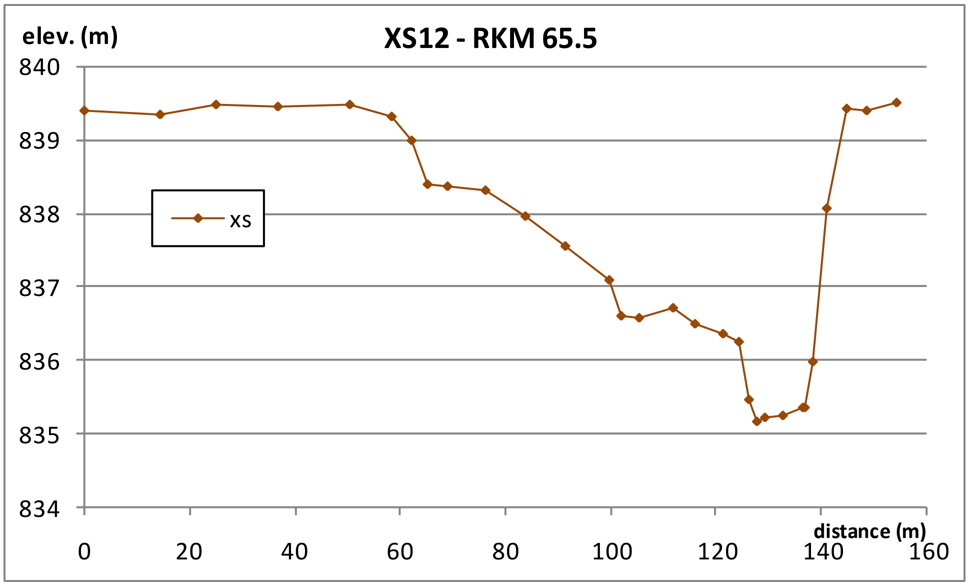
Graph 11 – XS9 at RKM 65.6



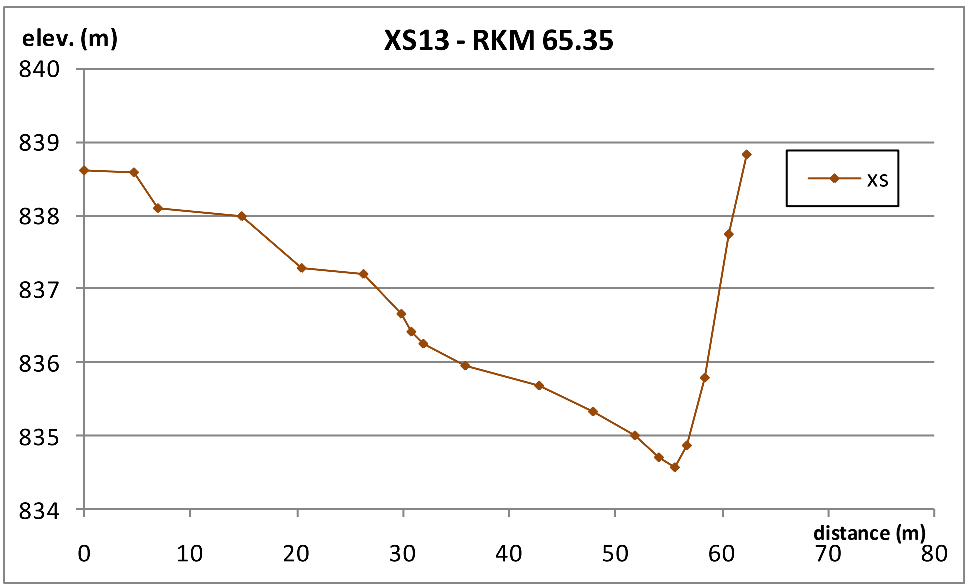
Graph 12 – XS10 at RKM 65.6



Graph 13 – XS11 at RKM 65.55



Graph 14 – XS12 at RKM 65.5



Graph 15 – XS13 at RKM 65.35

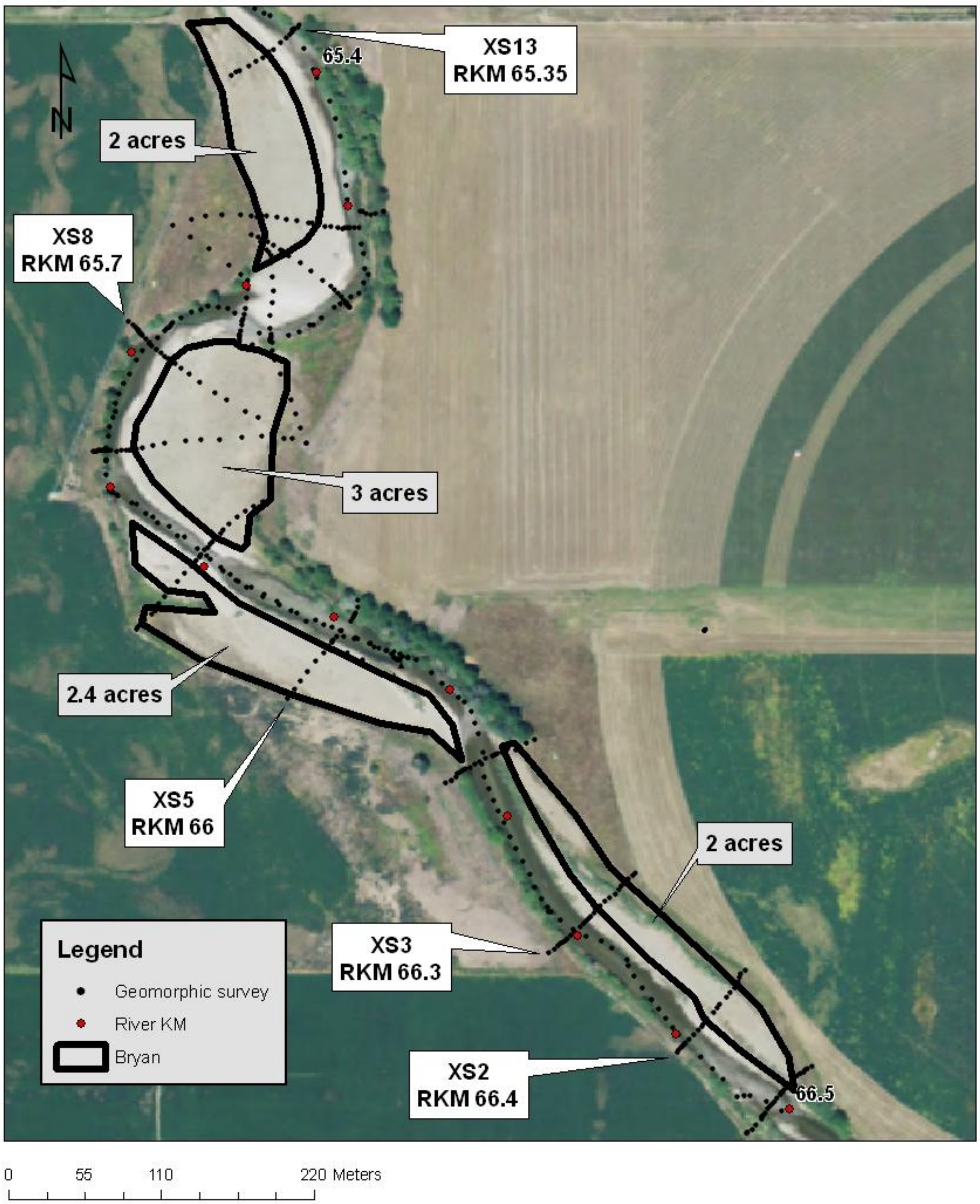
Calculated Bank Height and Channel Width

The distance from the river's thalweg to the top of the right and left bank was calculated for each cross section (Table 2). Both banks have approximately 4.0 meter (13 ft) rise from thalweg to top. There are multiple gravel bars and terraces that offer relatively flat surfaces for potential riparian re vegetation that are below the elevation of the top of bank. These bars and terraces include – river right XS1 – XS3, river left XS5 – XS6, river right XS7 – XS10 and river left XS10 – 13. There is one almost vertical cut bank in the survey reach – river right XS9 – XS11. The cut bank's height ranges from 3.0 m to 4.2 m from toe to top with a slope ranging from 25% to 75%.

Table 2 – bank height and channel width (meters)

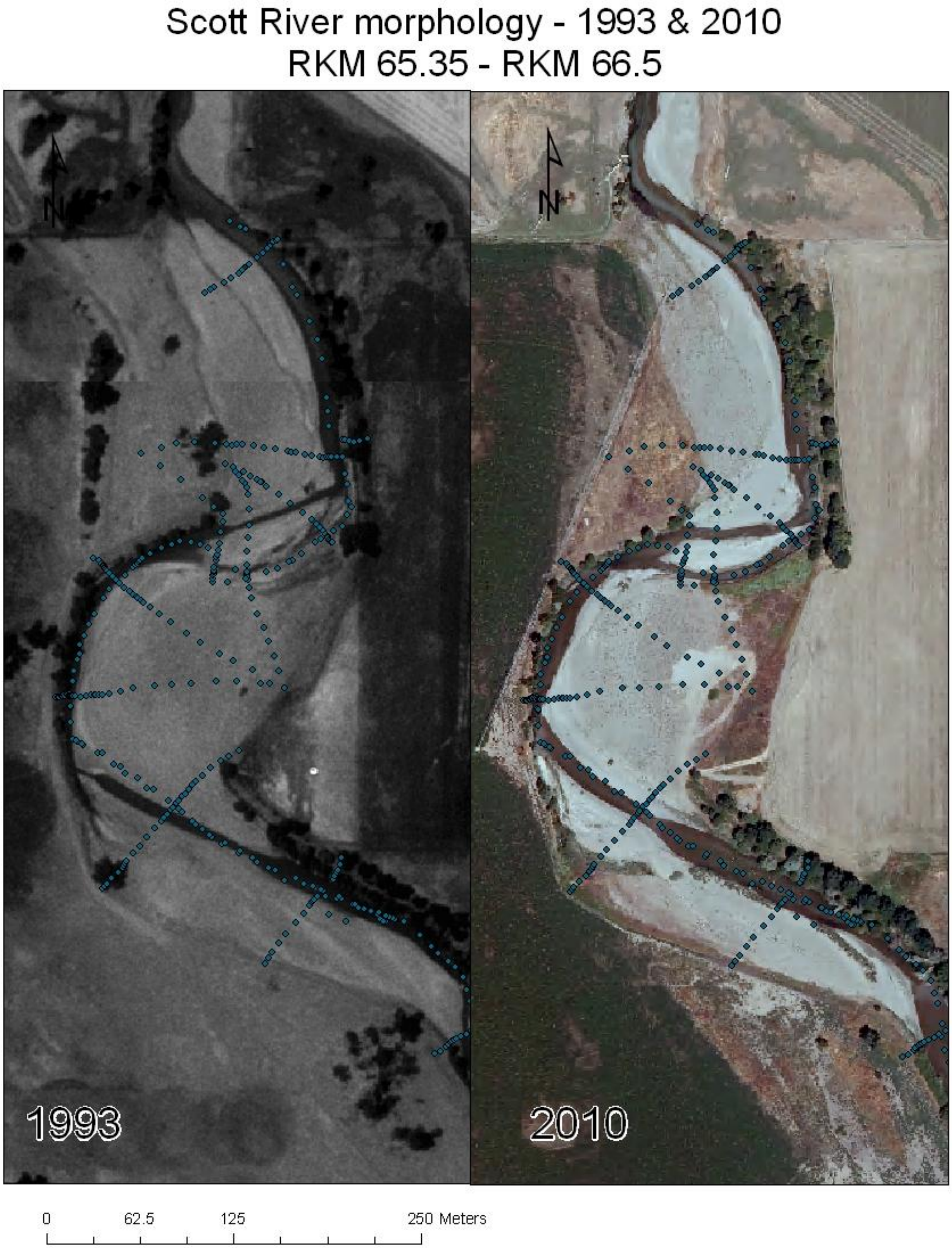
X-Section	RKM	Left Bank Height	Right Bank Height	Thalweg to Left Bank	Thalweg to Right Bank	Left Bank to Right Bank
1	66.5	4.2	4	26.6	34.9	61.5
2	66.4	4.5	4.9	7.2	64.5	71.7
3	66.3	3.9	4.2	20.9	49.7	70.6
4	66.15	3.8	3.7	20	31.9	51.9
5	66	4.3	4.2	72.4	6.6	79
6	65.9	4.4	3.7	69.5	44.9	114.4
7	65.8	4.2	4.7	9.2	82.9	92.1
8	65.7	4	3.8	17.6	85.4	103
9	65.6	4.1	3.9	34.9	18.9	53.8
10	65.6	3.7	4.3	75.5	17.8	93.3
11	65.55	3.8	3.1	77.5	6.6	84.1
12	65.5	3.8	2.9	65.6	13.4	79
13	65.35	4	4.2	55.6	6.8	62.4
Average		4.1	4.0			78.2

Potential Planting Sites - RKM 66.5 - 65.3



Map 3 – Potential Planting Sites – RKM 66.5 – 65.3

Map 3 – upstream portion of surveyed reach – aerial images from 1993 and 2010

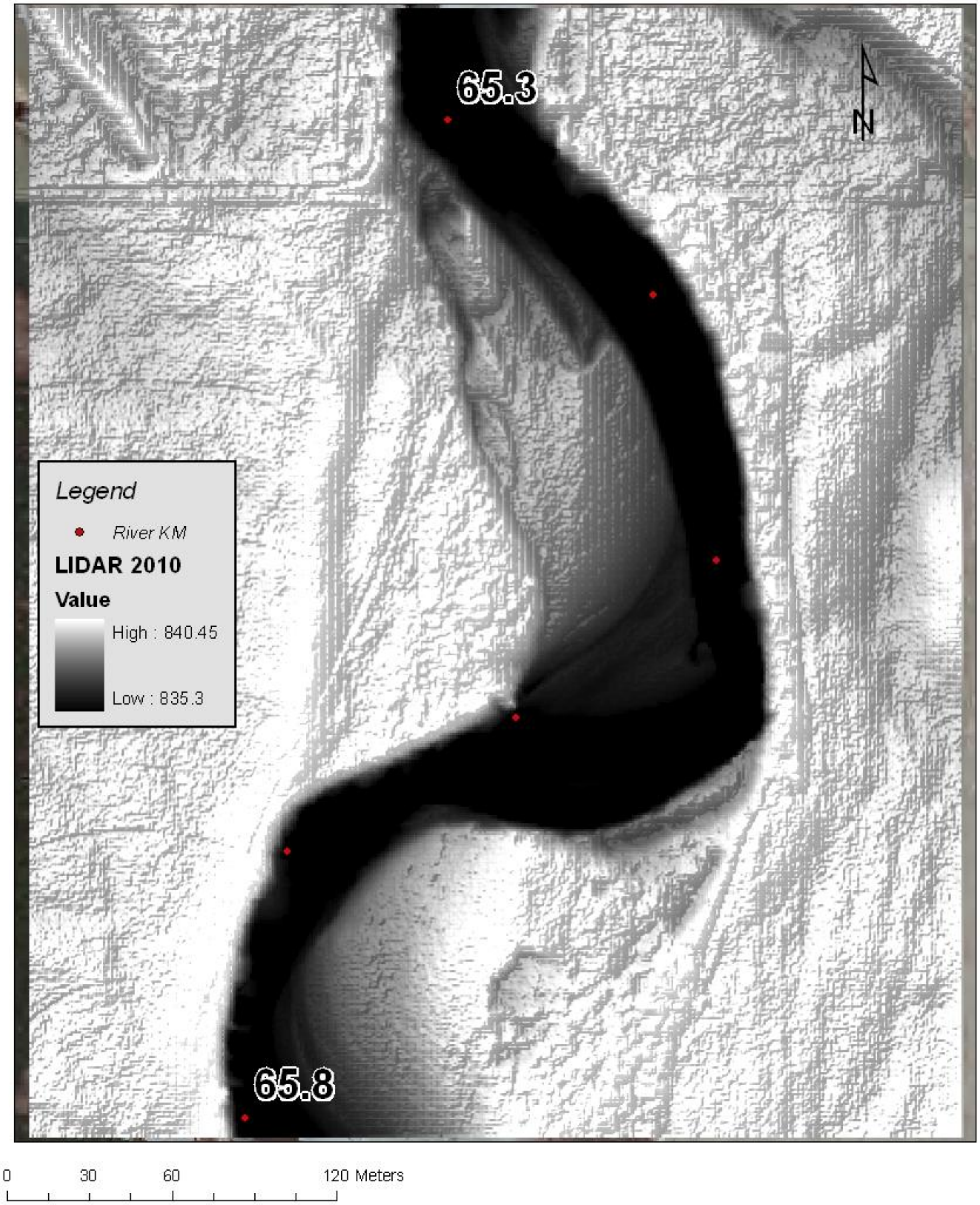


Map 4 – downstream portion of surveyed reach – aerial images from 1993 and 2010

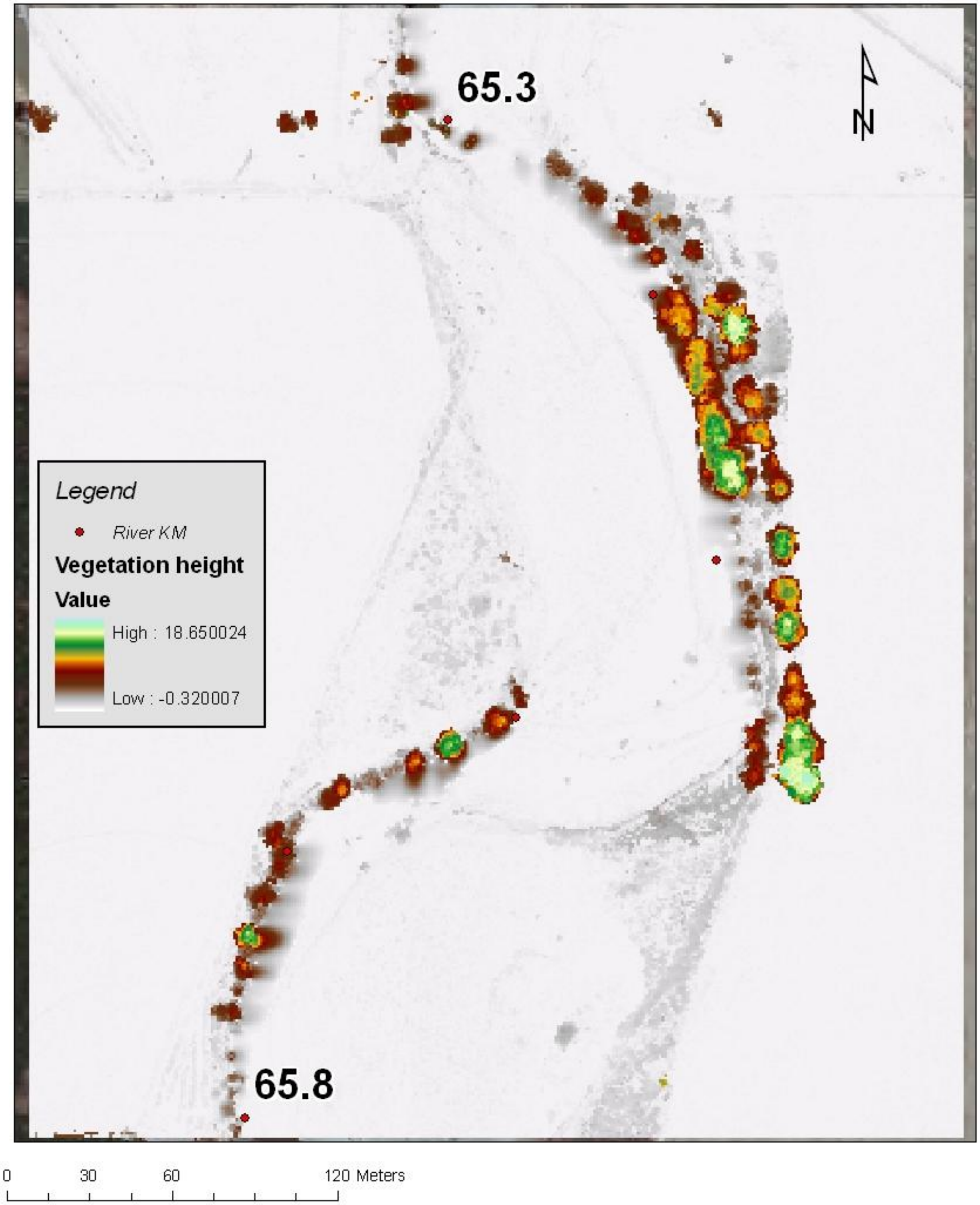
Analysis of aerial images from 1993 and 2010 (Maps 3 and 4) show that the channel alignment in this reach has been very stable over the 17 year span.

RKM 65.8 - 65.3 - NAIP 2010

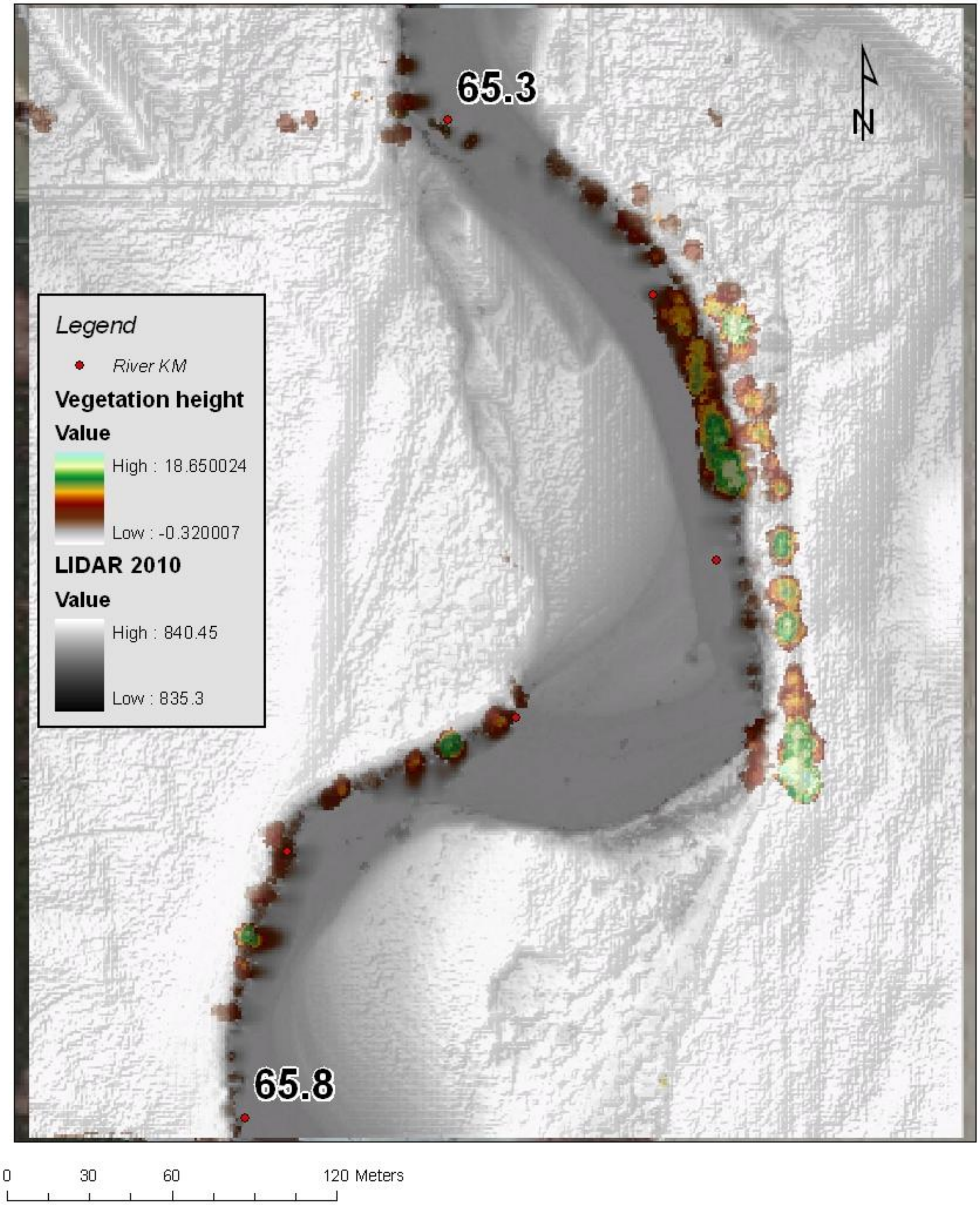
RKM 65.8 - 65.3 - LIDAR - Bare Earth



RKM 65.8 - 65.3 - LIDAR - Vegetation Height

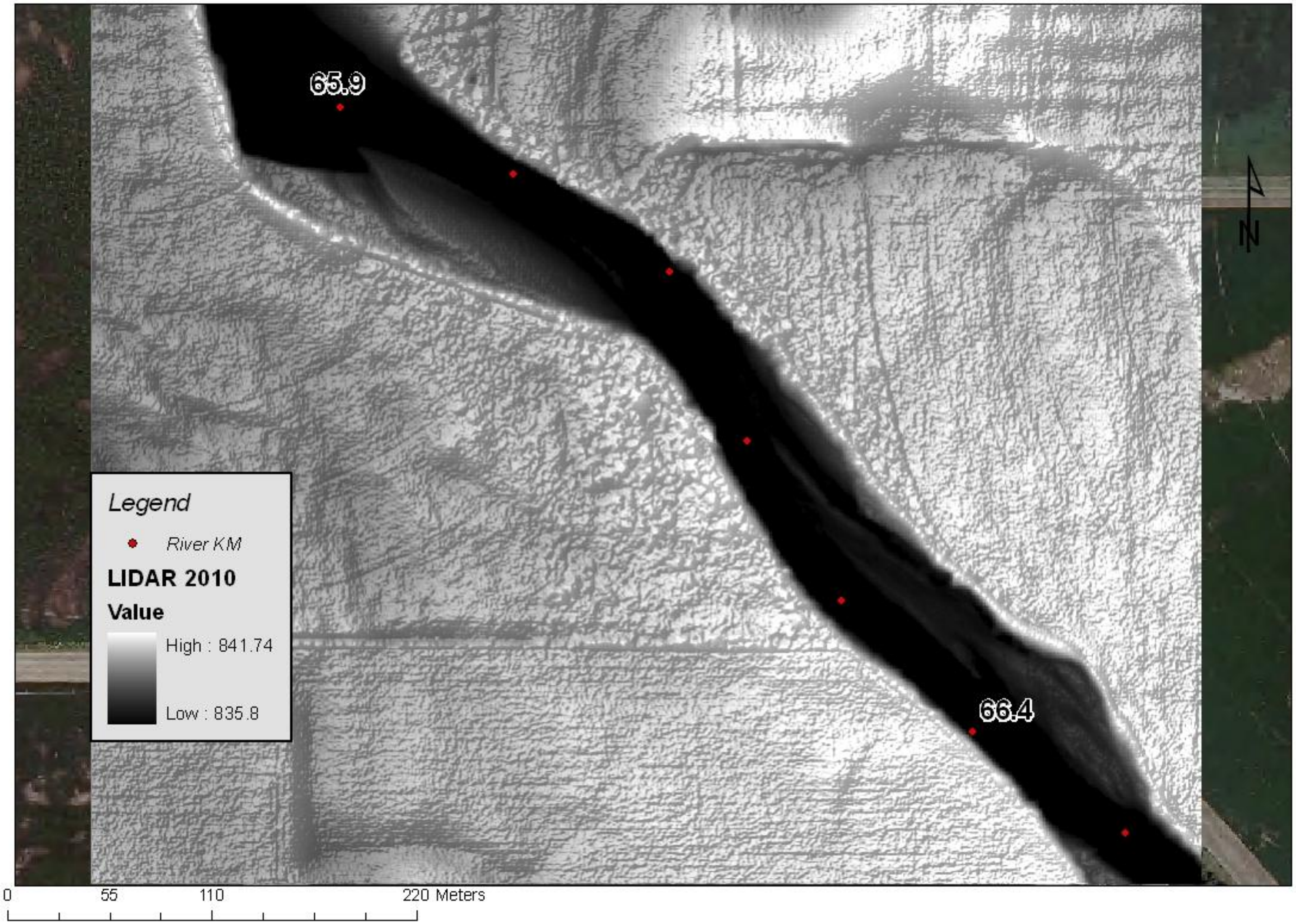


RKM 65.8 - 65.3 - LIDAR - Vegetation Height

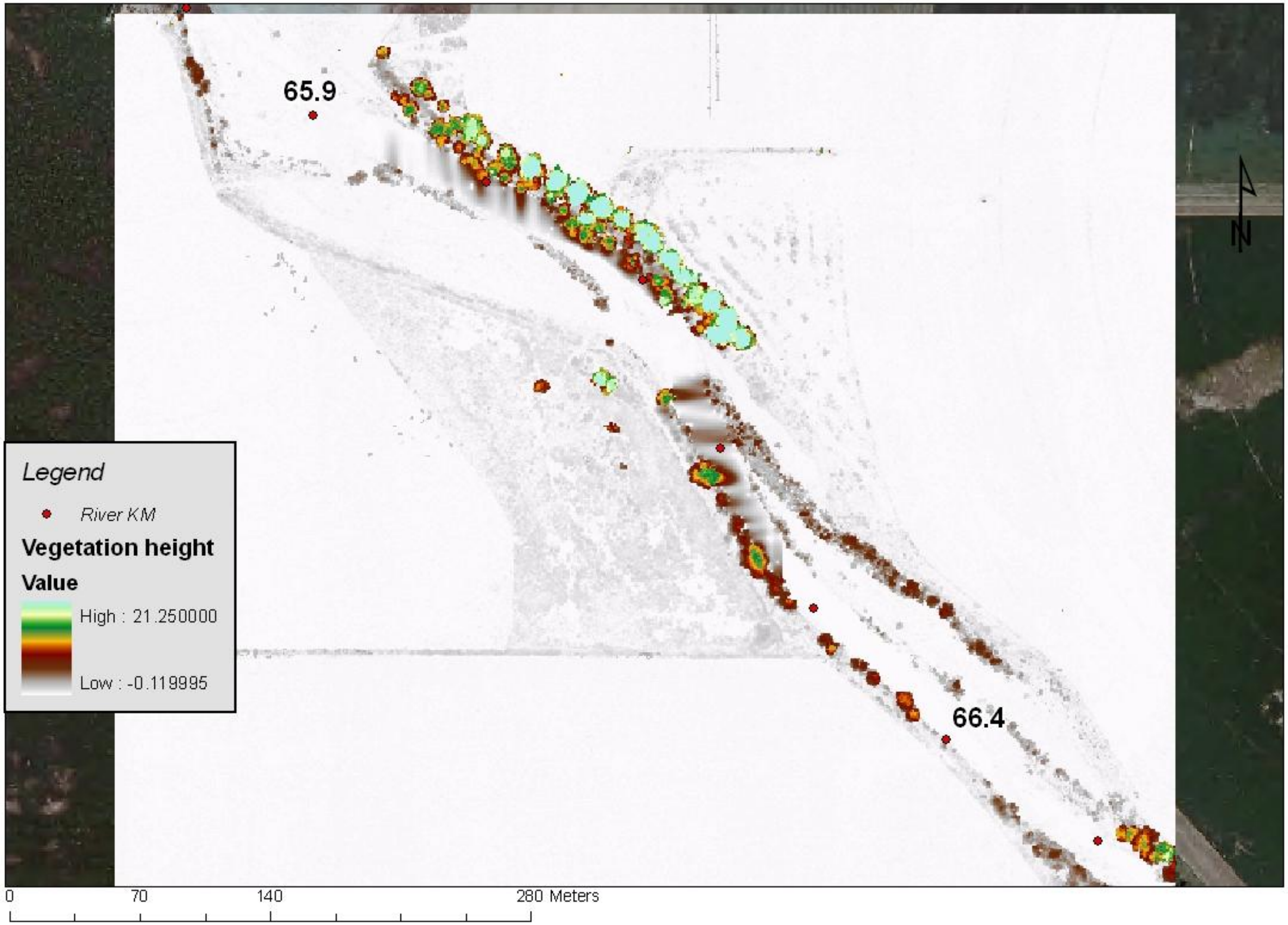


RKM 65.9 - 66.5 - NAIP 2010

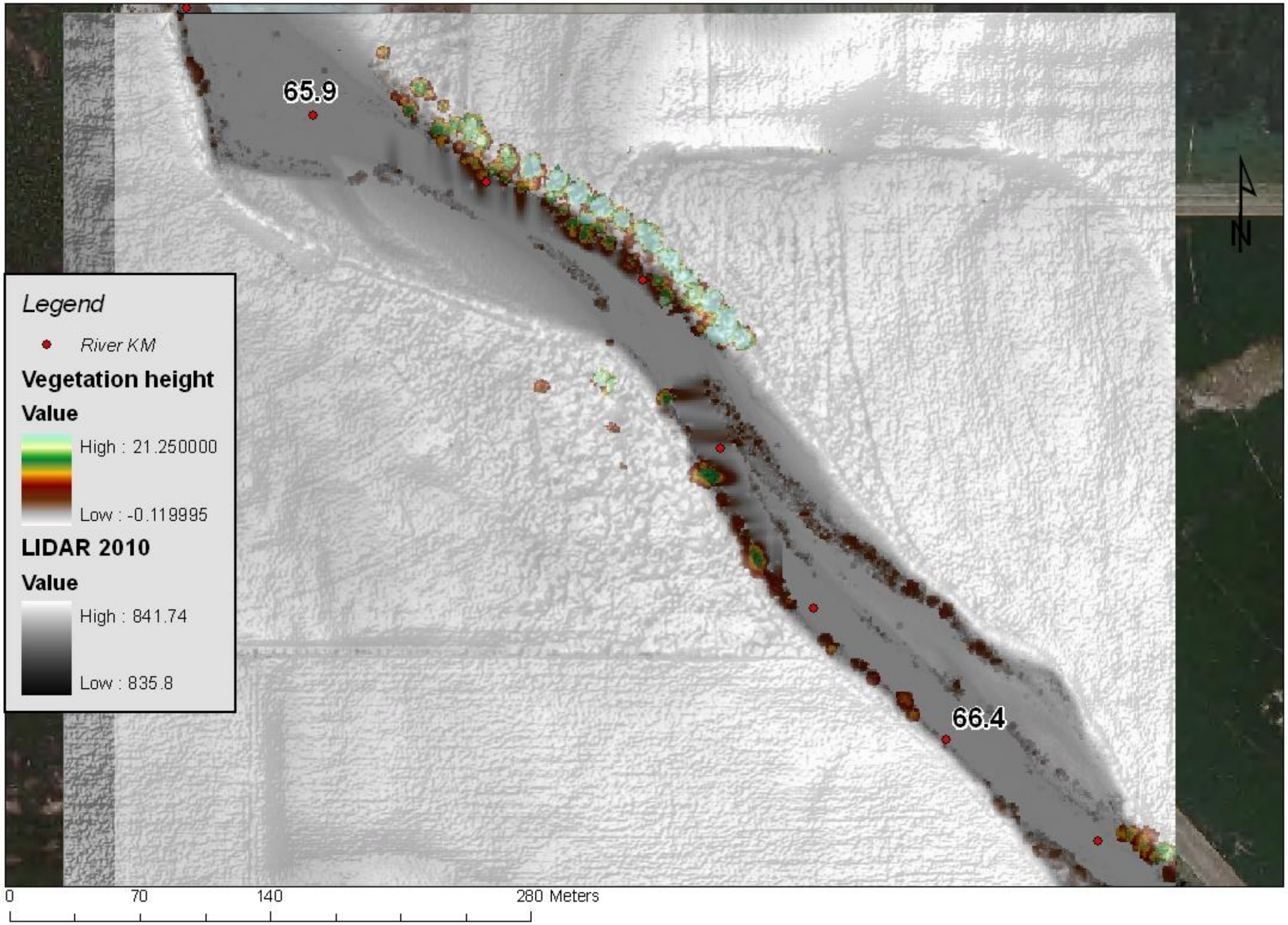
RKM 65.9 - 66.5 - LIDAR - Bare Earth



RKM 65.9 - 66.5 - Vegetation height

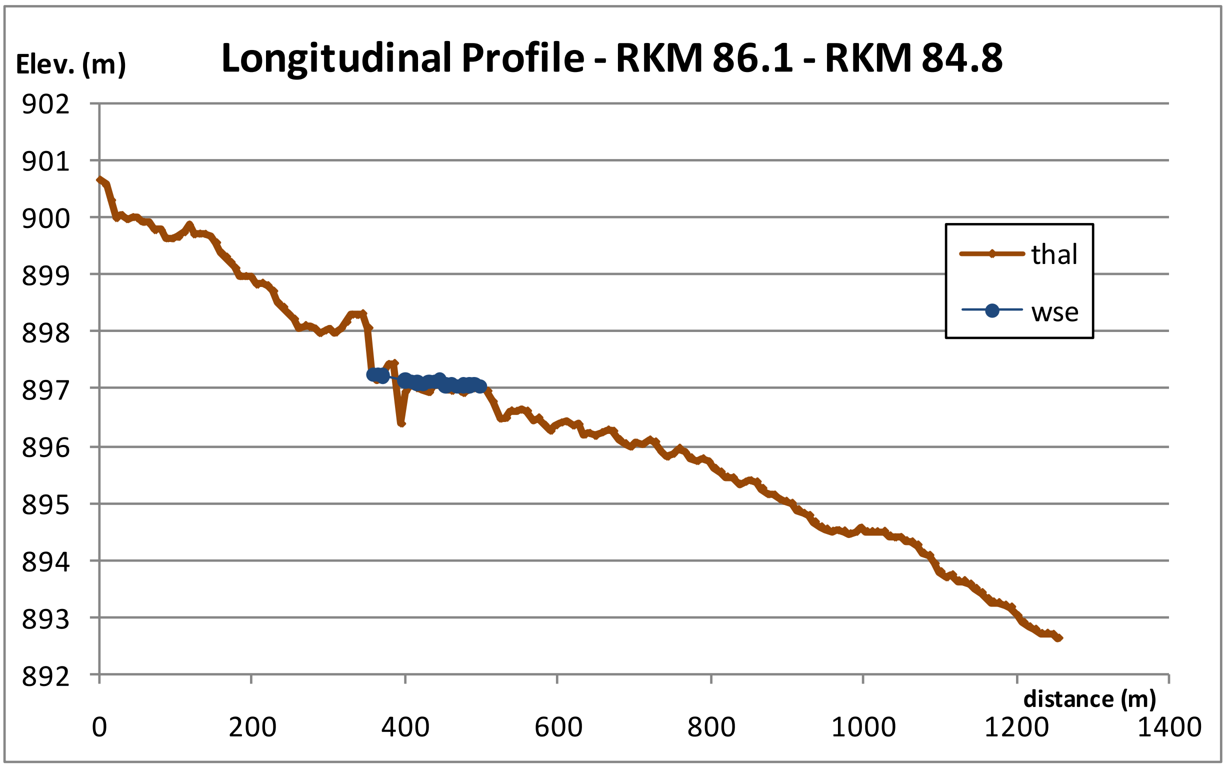


RKM 65.9 - 66.5 - Vegetation height



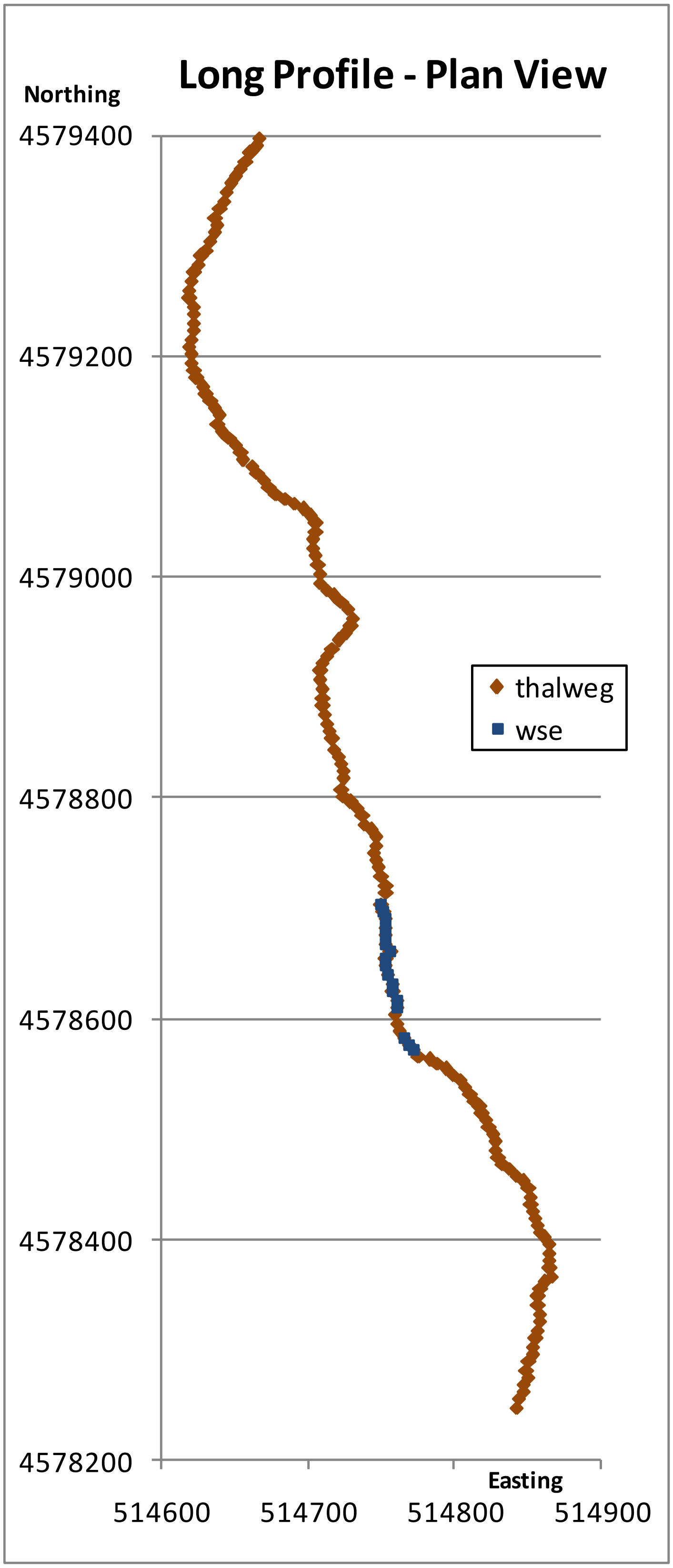
RKM 86.1 – RKM 84.8 - Alexander Property

The surveyed reach from RKM 86.1 – RKM 84.8 is located in the tailing reach of the Scott River downstream of Callahan. This reach was mostly dry during the survey period (10/14/2010). This reach is disconnected during the base flow period of most if not all water years. A section of wetted channel was documented from RKM 85.7 – RKM 85.6 indicating the water surface elevation in that location. Though the thalweg continued to lose elevation no surface water was observed downstream of this wetted area (Graph 1). The surveyed reach was approximately 0.5% slope.



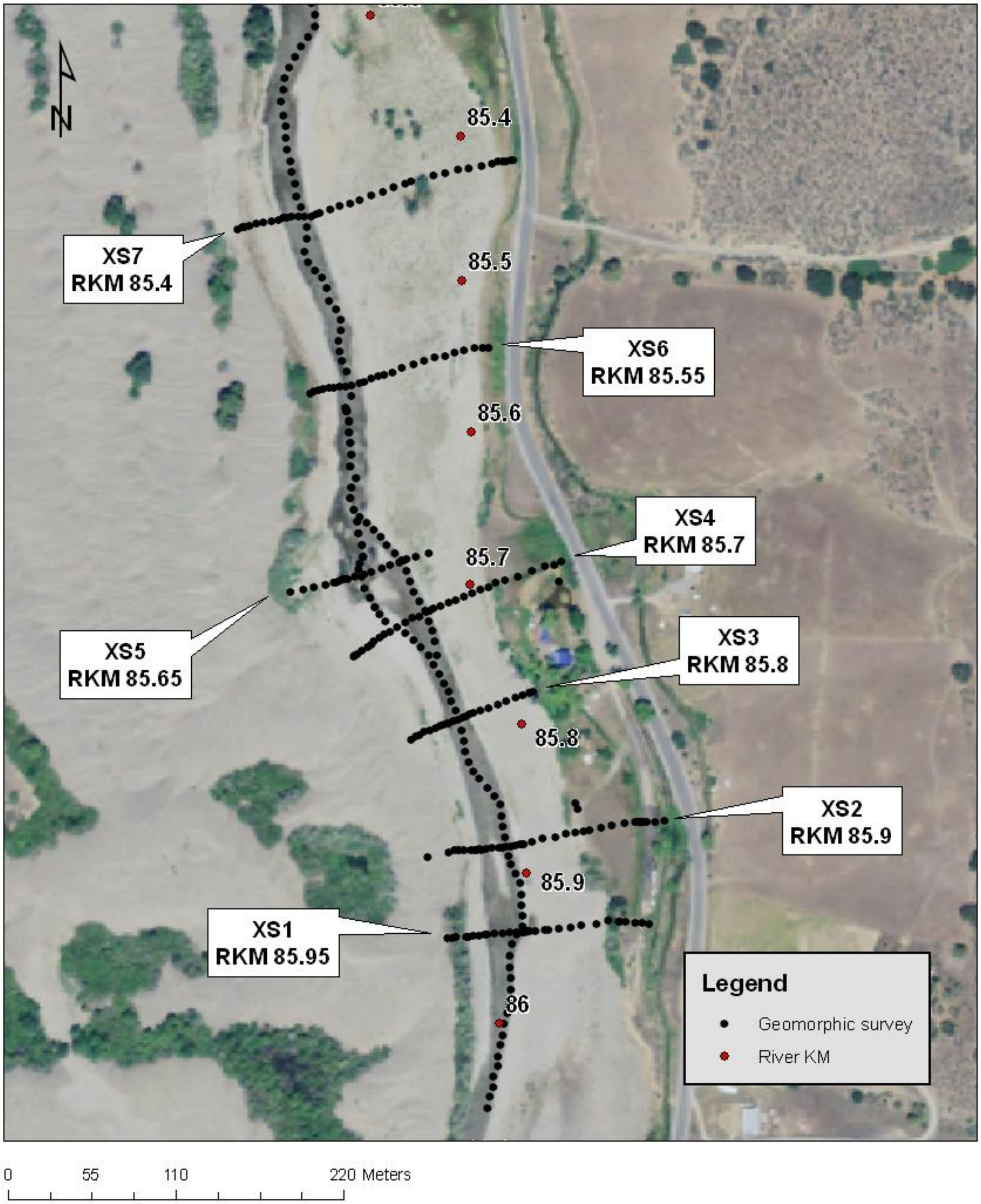
Graph 1 – Longitudinal profile of the Scott River thalweg – RKM 86.1 – 84.8

A Plan diagram of the surveyed reach is displayed in Graph 2.



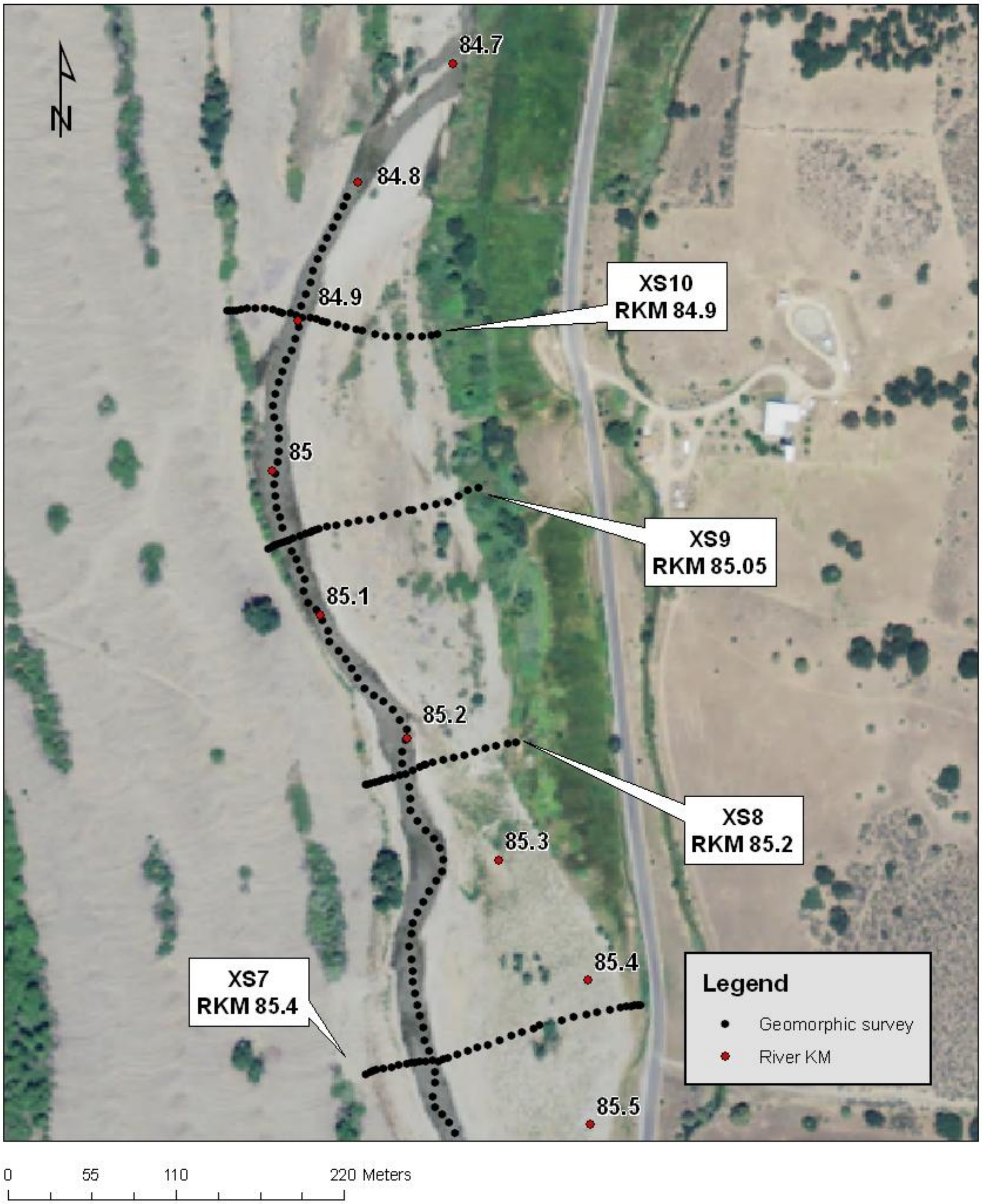
Graph 2 – Plan View of Longitudinal Profile

Scott River Geomorphic Survey - RKM 86.1 - 84.8



Map 1 – up stream portion of surveyed reach – RKM 86.1 – RKM 84.8

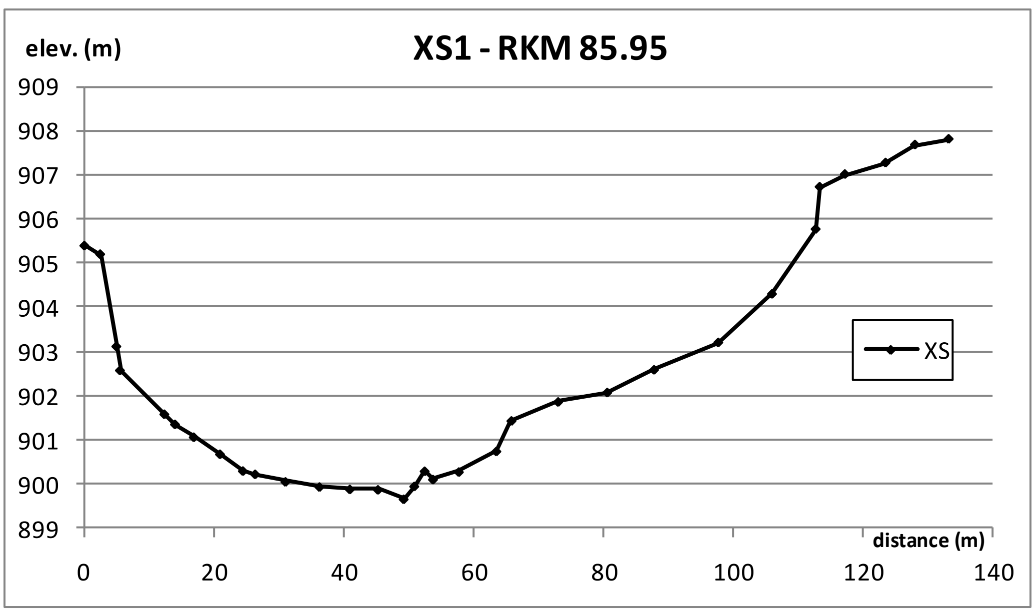
Scott River Geomorphic Survey - RKM 86.1 - 84.8



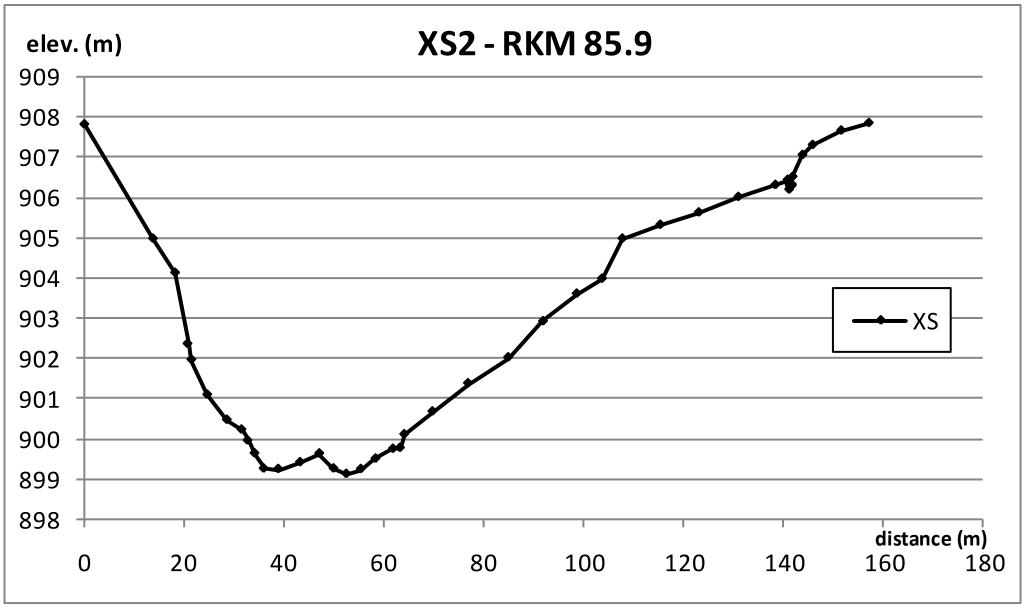
Map 2 – downstream portion of surveyed reach – RKM 86.1 – RKM 84.8

Stream KM	Potential Shade	Current Shade	Potential Shade Increase
86.1	0.17	0.03	0.14
86	0.19	0.06	0.13
85.9	0.15	0.03	0.12
85.8	0.24	0.05	0.19
85.7	0.24	0.04	0.2
85.6	0.38	0.05	0.33
85.5	0.38	0.09	0.29
85.4	0.49	0.07	0.42
85.3	0.28	0.04	0.24
85.2	0.48	0.07	0.41
85.1	0.21	0.08	0.13
85	0.21	0.13	0.08
84.9	0.1	0.04	0.06
84.8	0.12	0.03	0.09

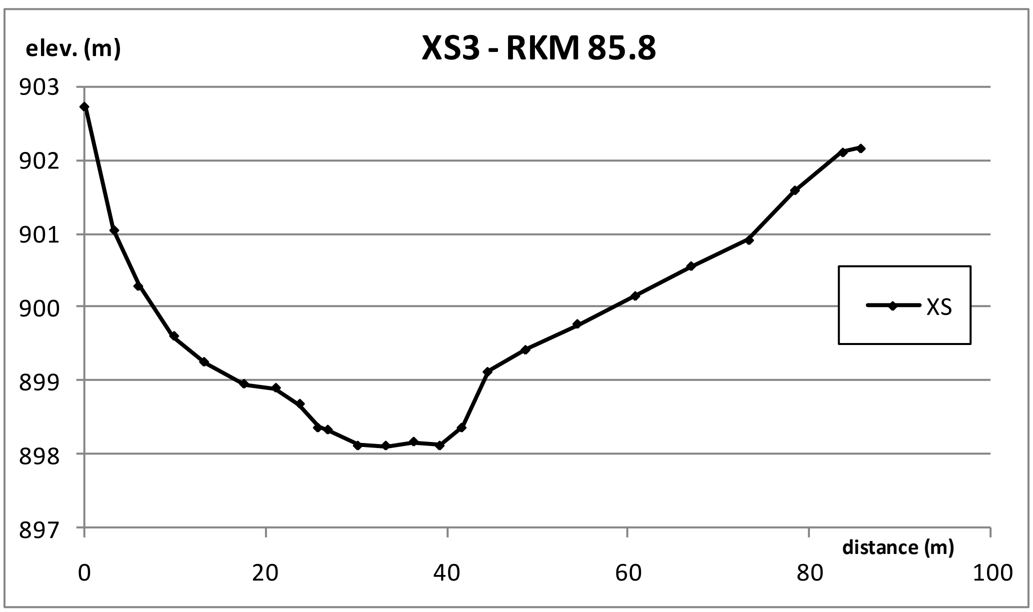
Table 1 – Potential and current shade from NCRWQCB Staff Report for Scott River TMDL



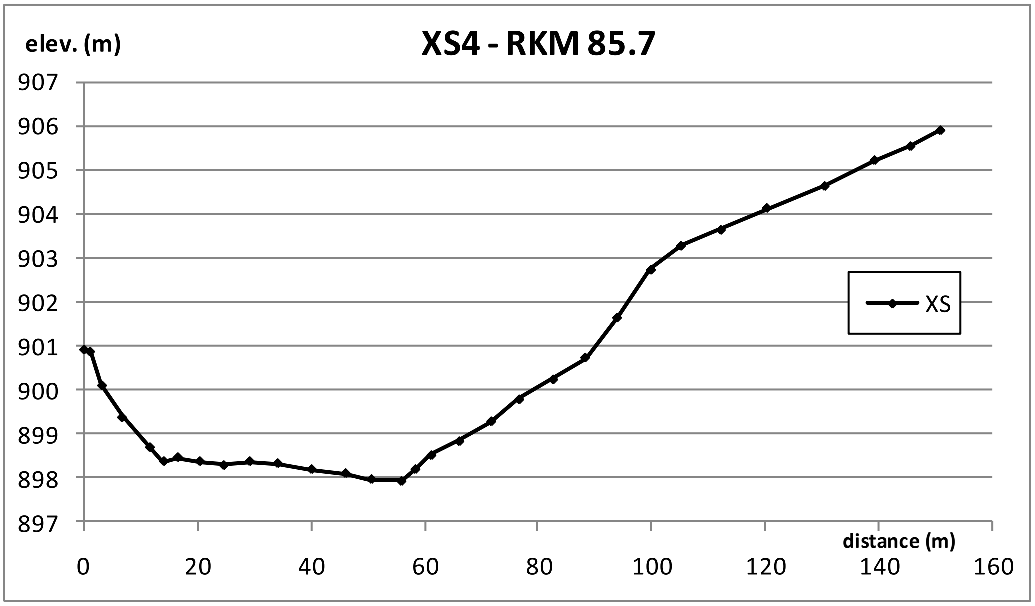
Graph 3 – XS1 at RKM 85.95



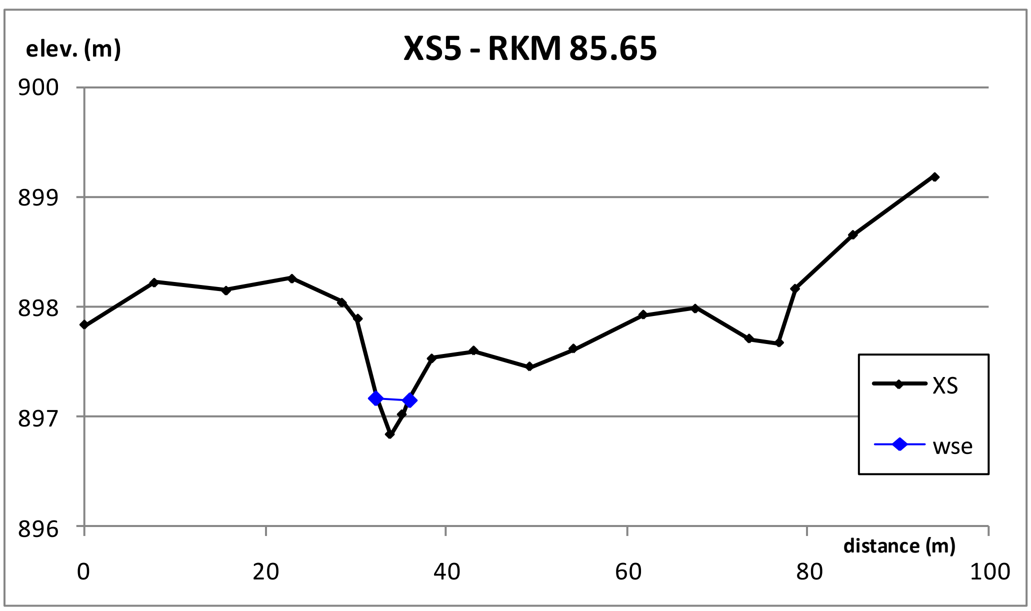
Graph 4 – XS2 at RKM 85.9



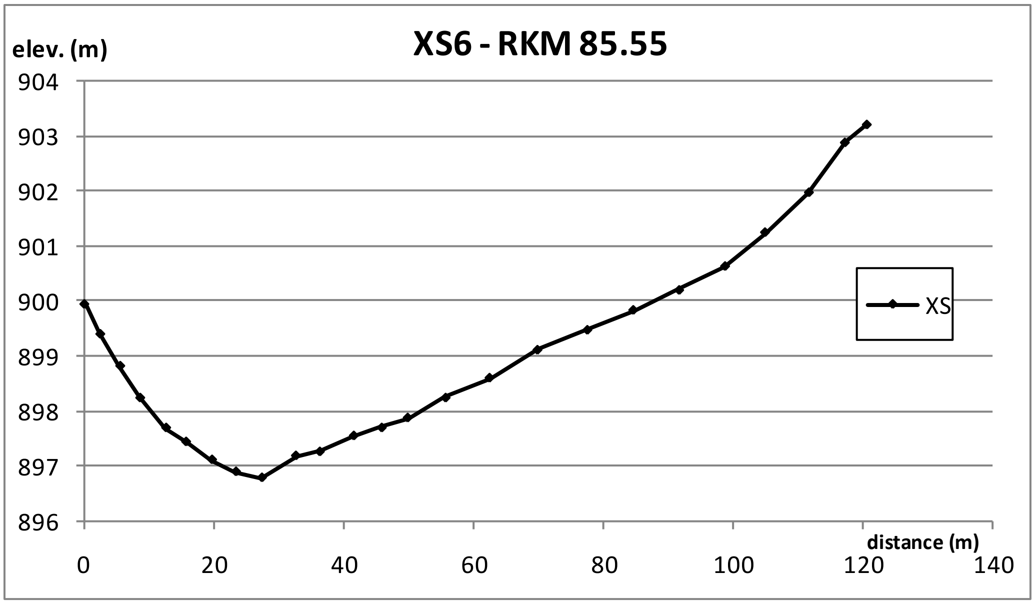
Graph 5 – XS3 at RKM 85.8



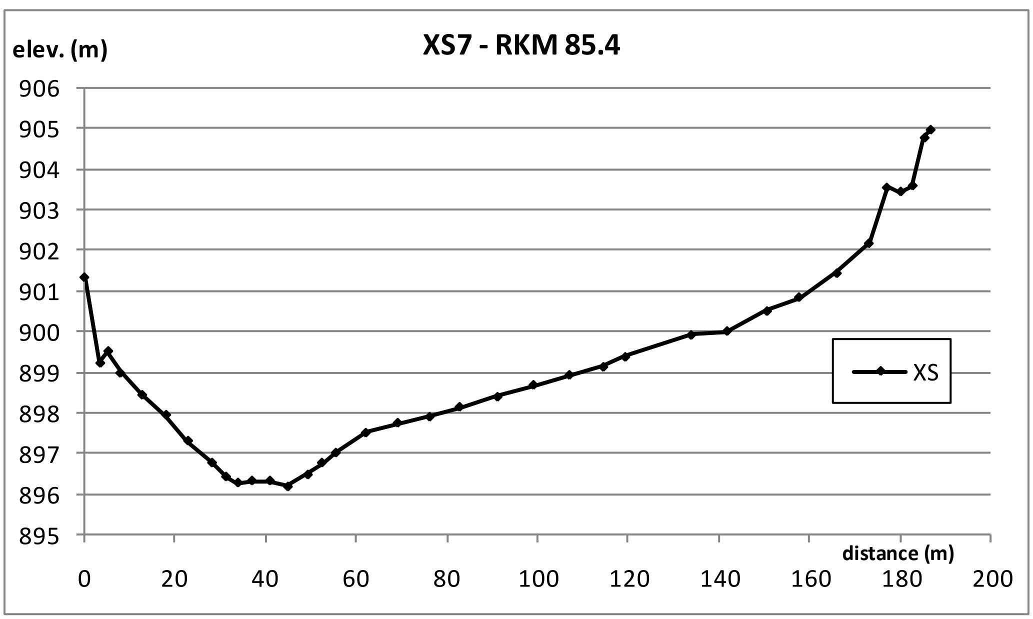
Graph 6 – XS4 at RKM 85.7



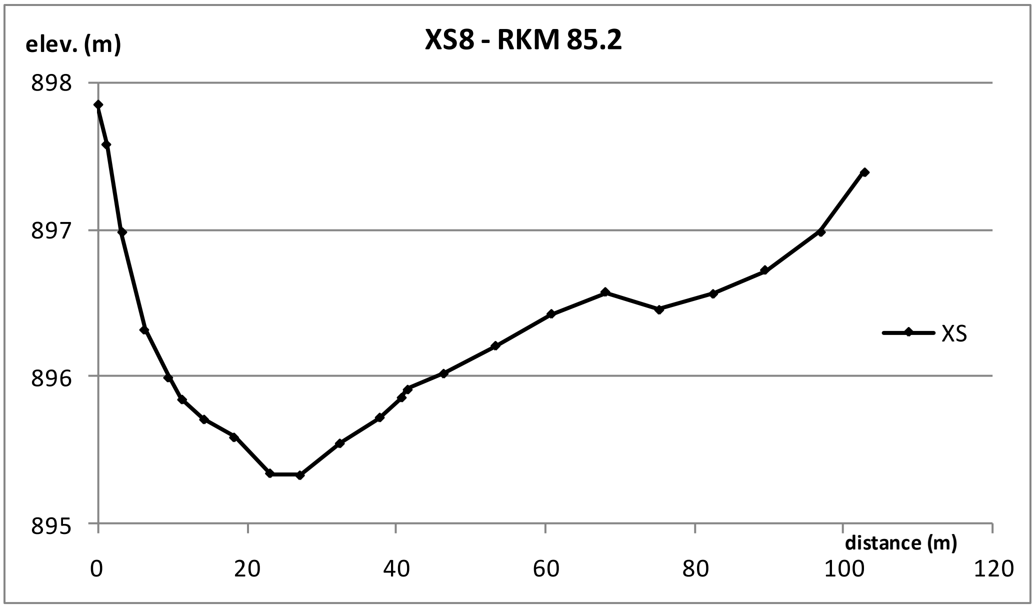
Graph 7 – XS5 at RKM 85.65



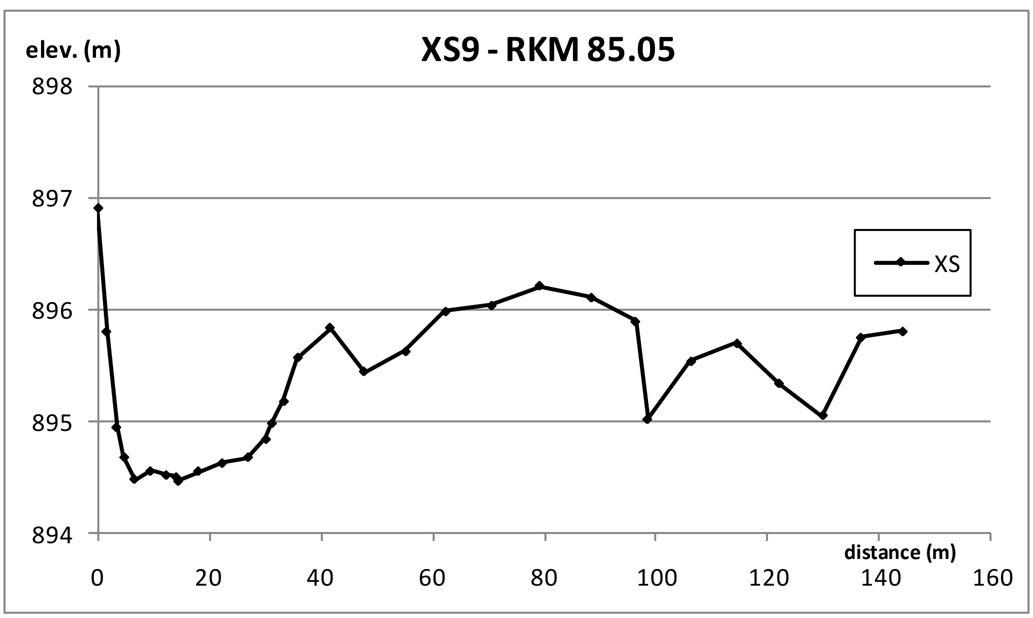
Graph 8 – XS6 at RKM 85.55



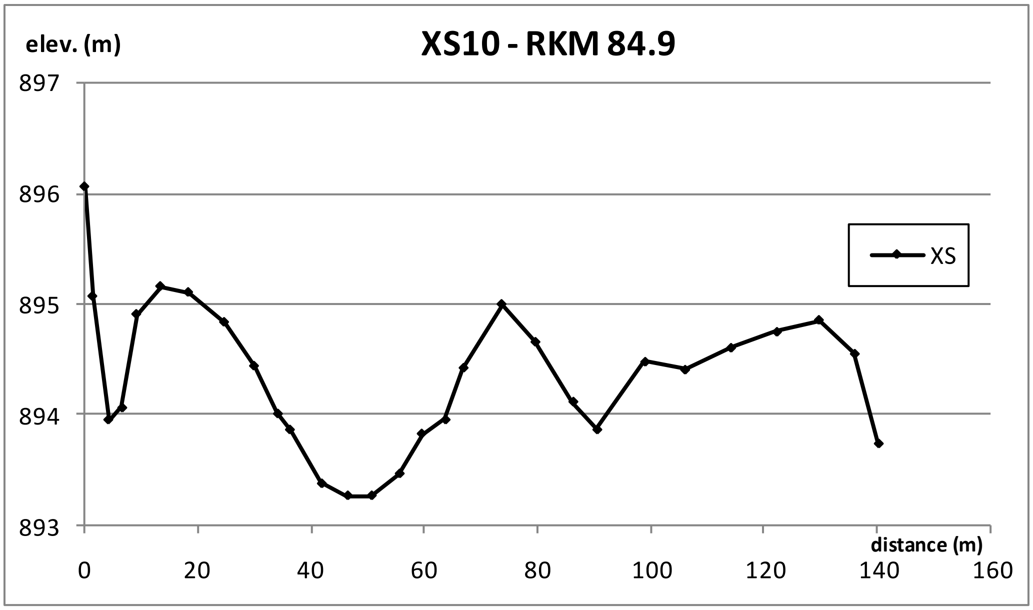
Graph 9 – XS7 at RKM 85.4



Graph 10 – XS8 at RKM 85.2



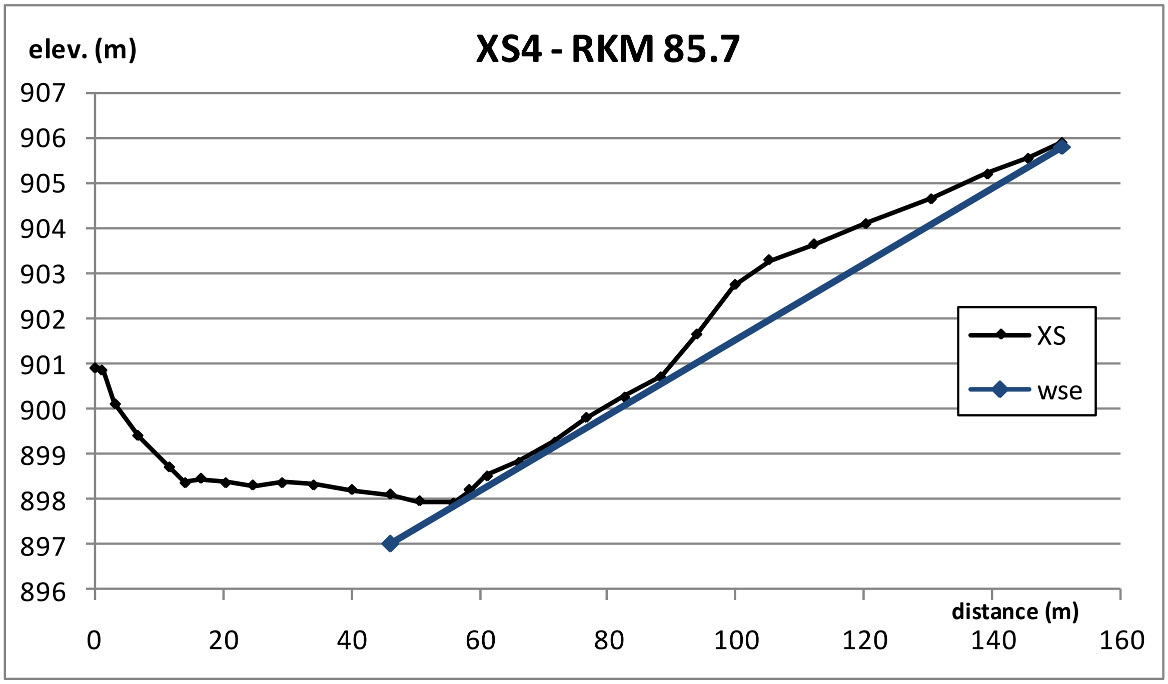
Graph 11 – XS9 at RKM 85.05



Graph 12 – XS10 at RKM 84.9

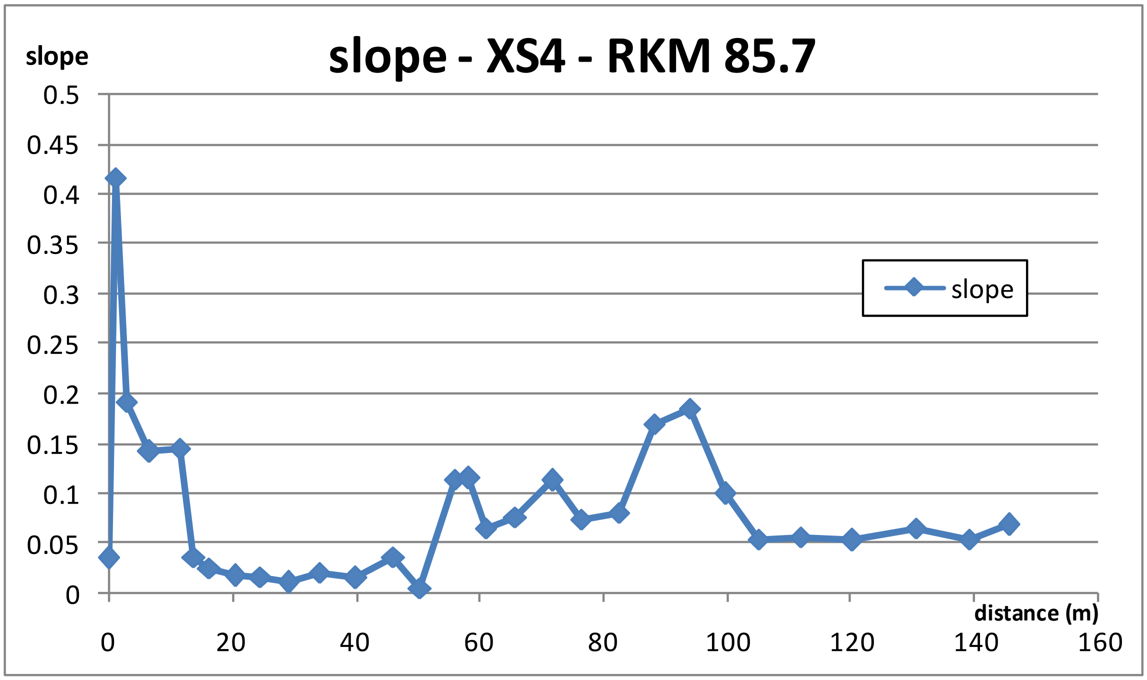
Analysis of potential water surface elevation and planting site

Around the location of XS4 (RKM 85.7) water surface elevations (WSE) of water was surveyed at a pond above the channel (WSE = 905.8 m) and in the channel at the beginning of the connected reach (WSE = 897 m). If we assume the gradient of the water between these two points is linear then a graph of WSE and ground elevations show that the stream bank is only slightly higher than the WSE for approximately 30 meters (Graph 13).



Graph 13 – surveyed water surface elevations (wse) and ground elevations (XS) at RKM 85.7

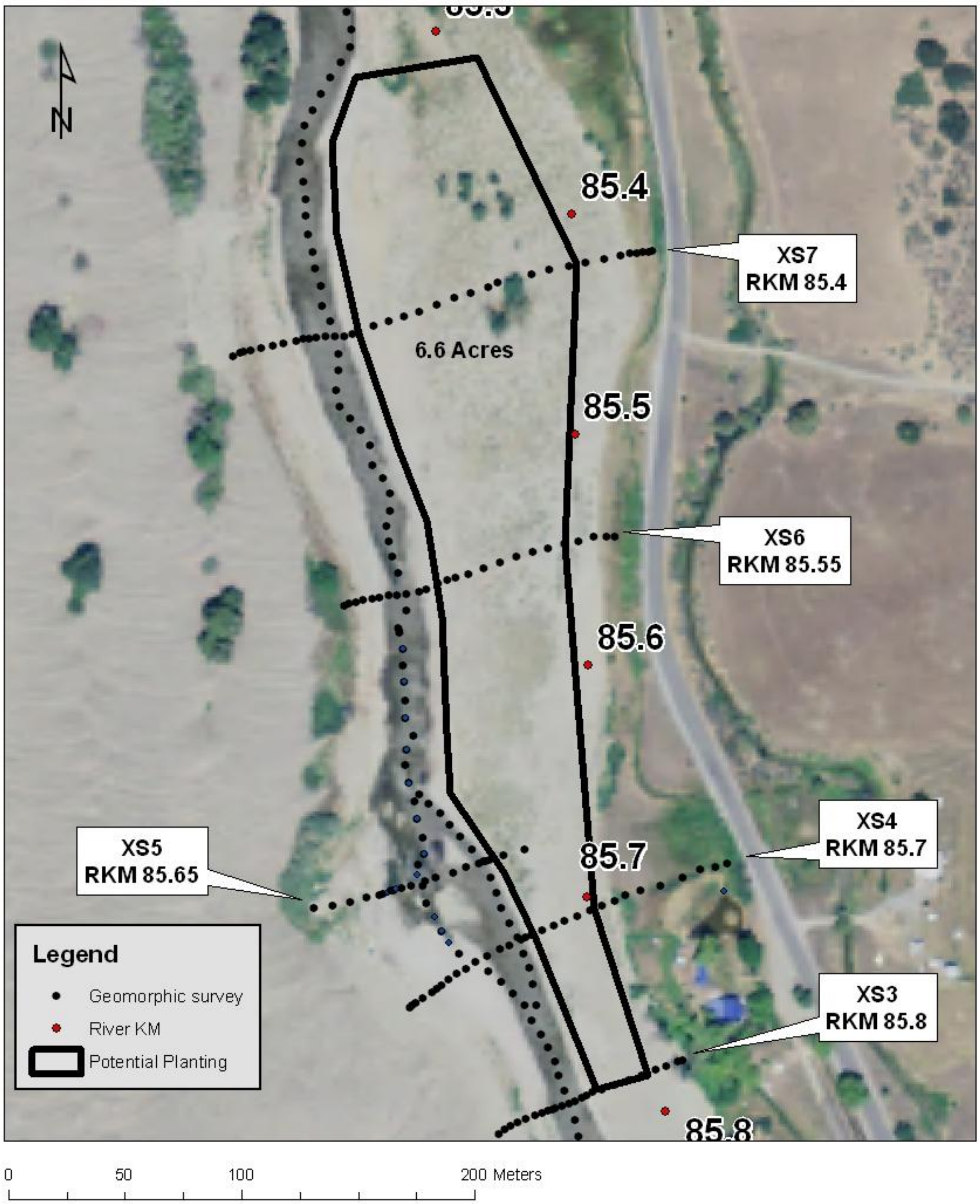
This area of stream bank that is close to the potential WSE is a good candidate for riparian planting. Excavation of "test holes" in this area could help verify the water surface during the base flow period. Analysis of the ground slope in this section with potential high water table shows a range of approximately 5% - 10% (Graph 14). A break in grade occurs at an elevation of 901 meters, the location at which the ground elevation diverges from the potential water table elevation.



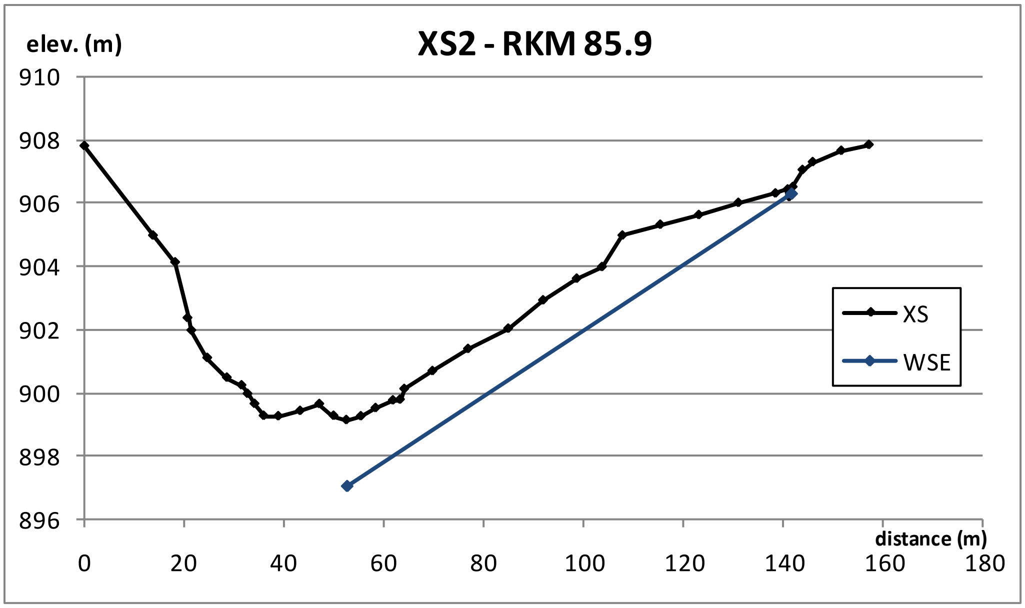
Graph 14 – Calculated slope at XS 4

From this analysis it is proposed that an area for riparian plantings with a higher likelihood of success exists in the stream bank between the banks edge and the grade break at 901 m. Extending this criteria downstream and upstream from XS 4 through XS 7 (RKM 85.8 – RKM 85.4) delineates a potential planting area of approximately 6.6 acres (Map 3). It is proposed that a narrower corridor could be planted on the downstream end (e.g. set the upslope boundary to an elevation less than 901 m) if there is concern that the water table elevation is lower downstream of the irrigation ditch and pond. Planting efforts could start in the locations adjacent to the stream channel and move upslope until excavation shows that the water table is significantly lower than the ground elevation.

Potential Riparian Planting - RKM 85.8 - 85.5



Map 3 – Potential area for planting

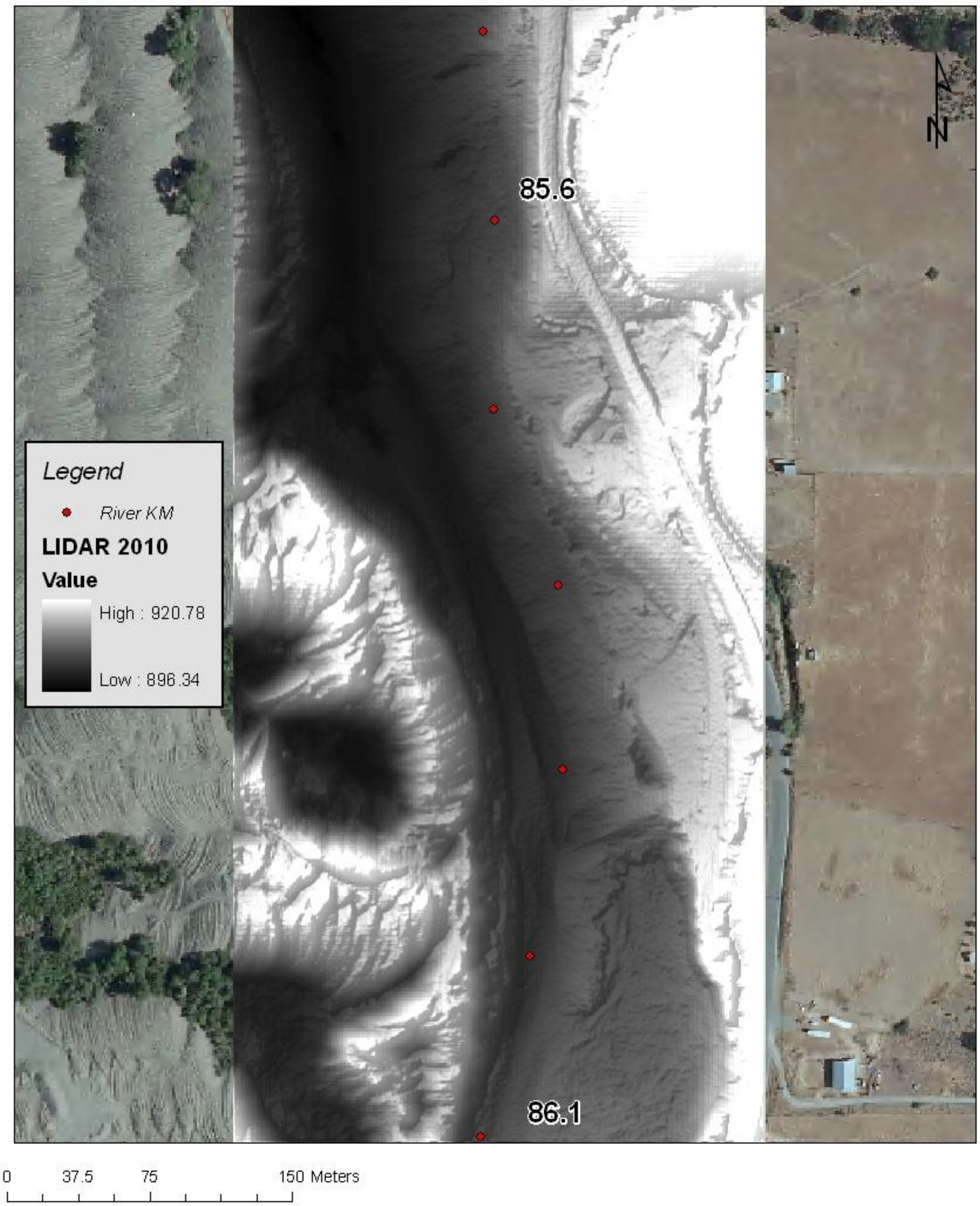


Graph 15 – surveyed and potential water table elevation at XS2

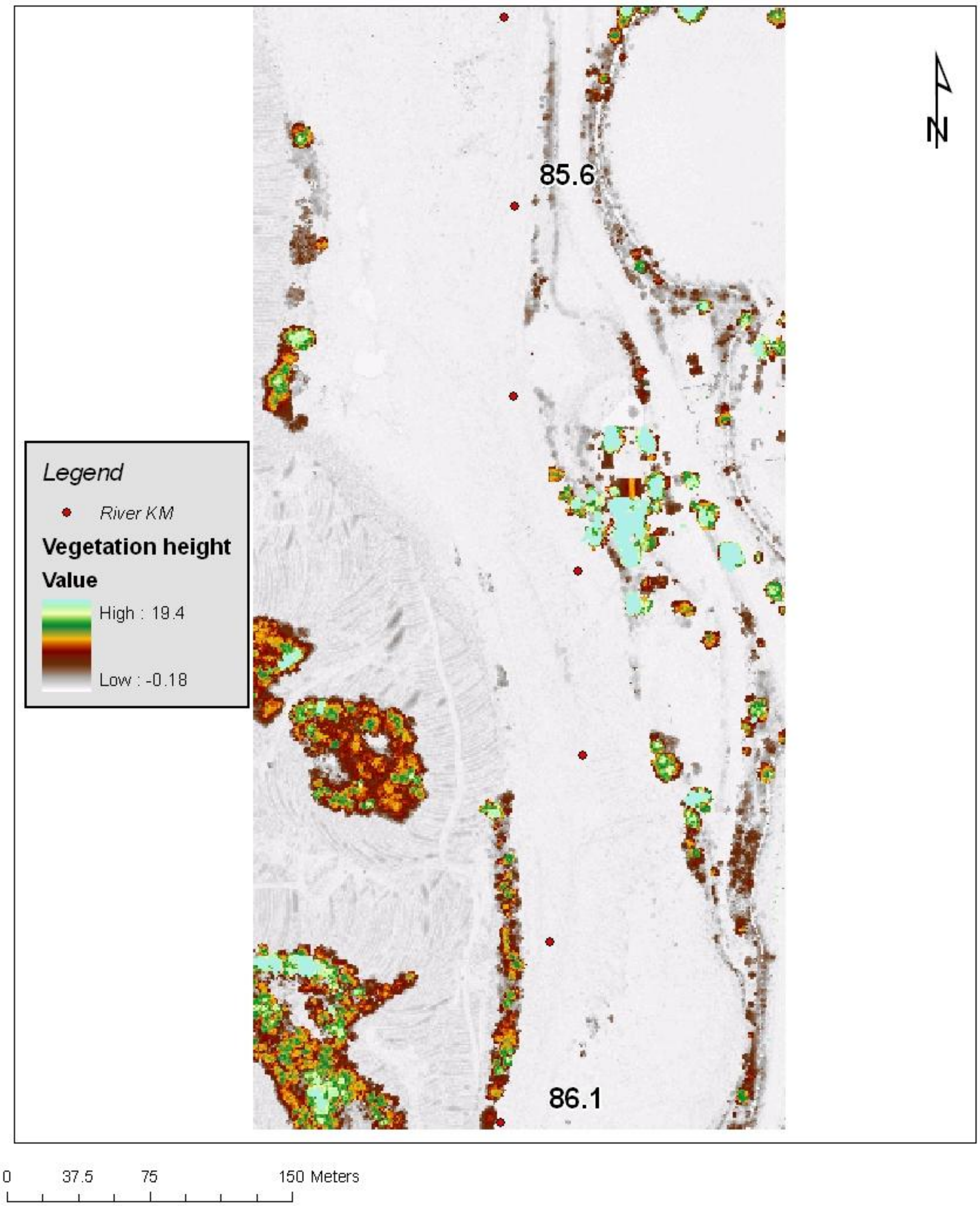
The water surface elevation in the ditch that feeds the pond was surveyed at XS2 (WSE = 906 m). No surface water was observed in the channel at this cross section. If we hypothesize that the water table elevation is approximately equal to the elevation observed downstream (897 meter) then a potential water table elevation could be generated for XS2 (Graph 15). This potential water table elevation is significantly lower than the observed ground elevations. If the water table elevation in the channel is actually significantly higher than the downstream elevation than the relation between ground and water table elevations would be closer making this a suitable site for planting in conjunction with the proposed site downstream. Further inquiries into the relation of the water table elevation and the ground elevation in this reach would help identify areas with a relatively high water table and potential success for plantings.

Appendix – imagery from 2010 NAIP aerial photography and LIDAR

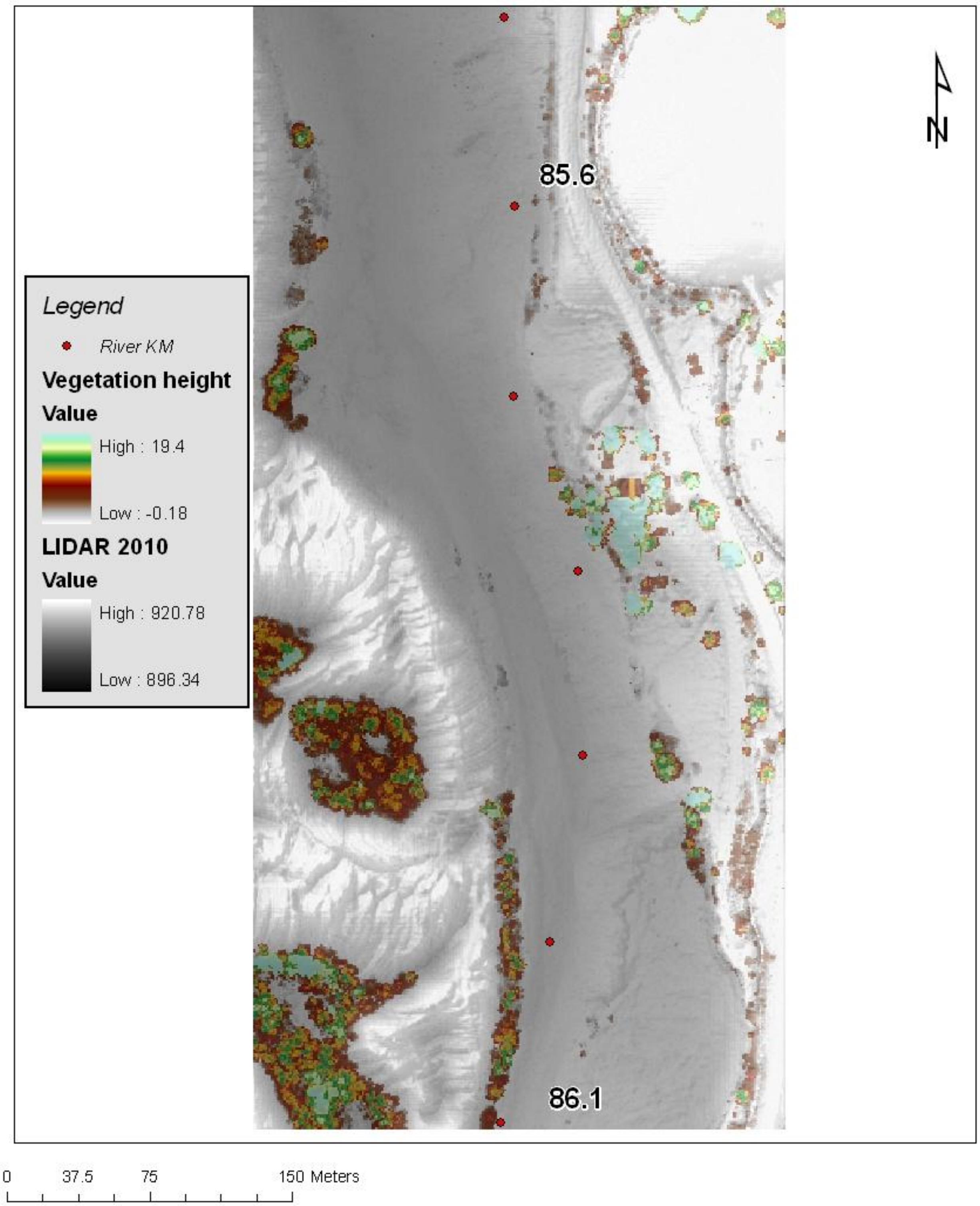
RKM 86.1 - 85.5 - LIDAR - Bare Earth



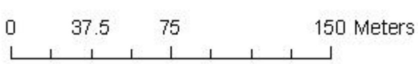
RKM 86.1 - 85.5 - LIDAR - Vegetation Height



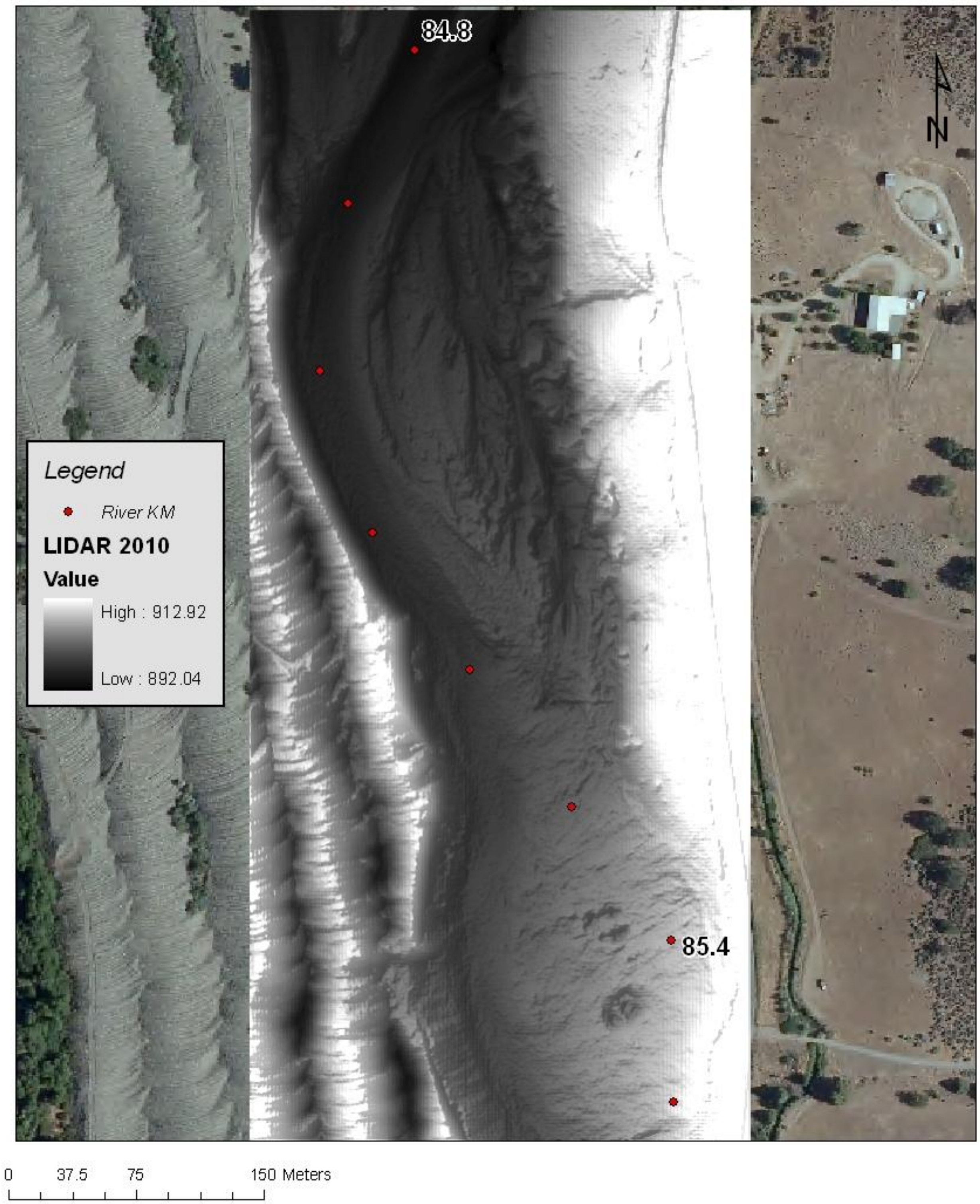
RKM 86.1 - 85.5 - LIDAR - Vegetation Height



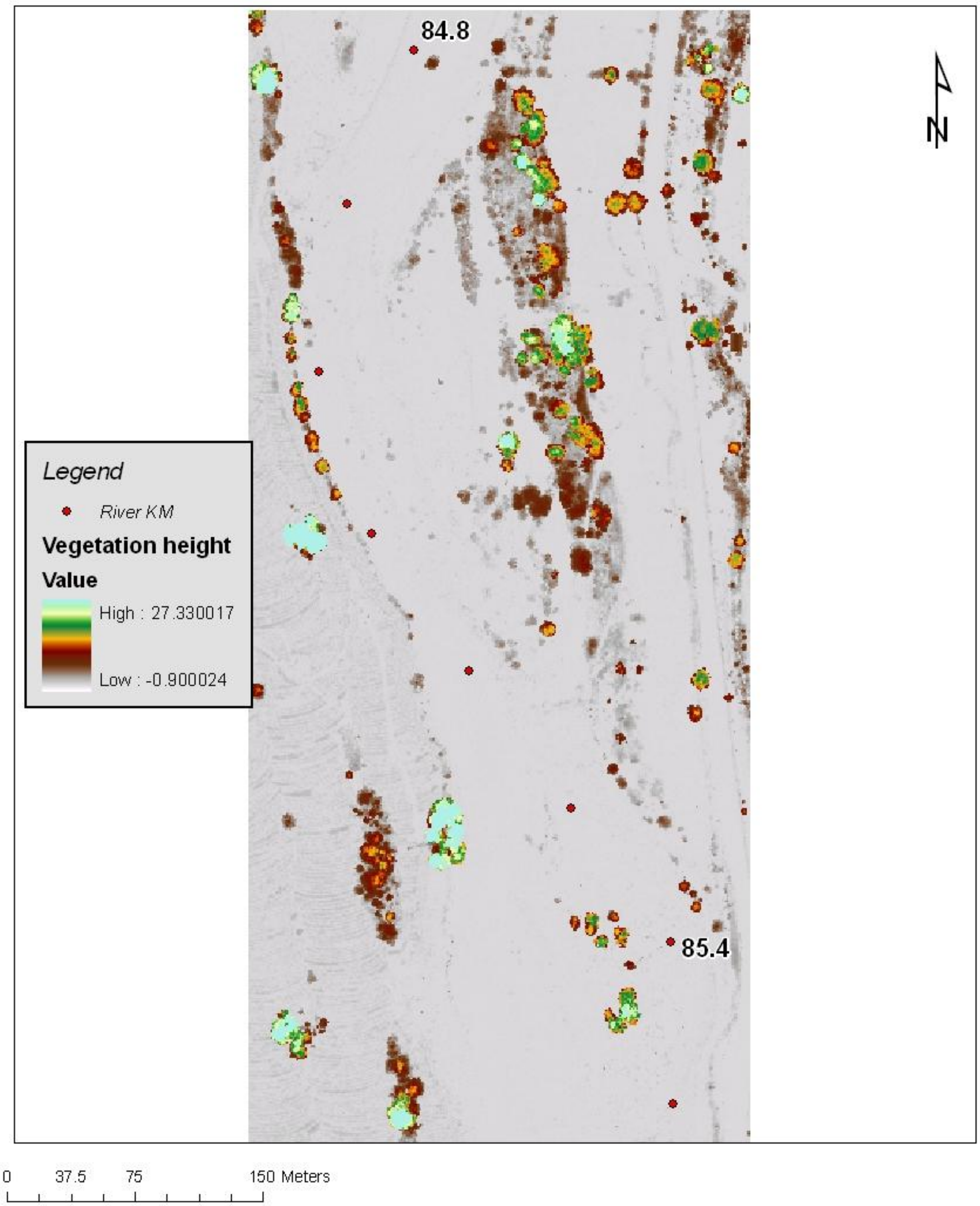
RKM 85.5 - 84.8 - NAIP 2010



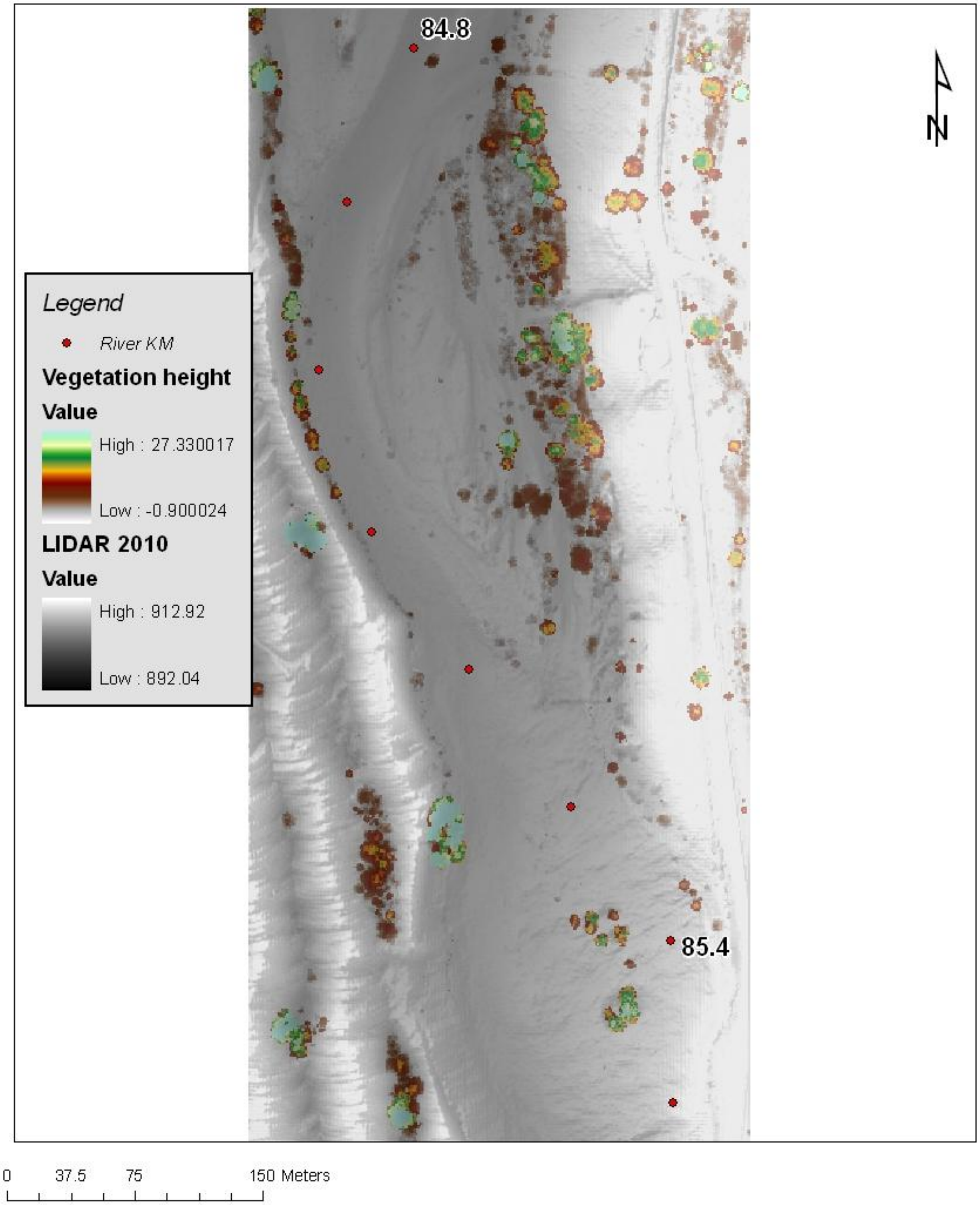
RKM 85.5 - 84.8 - LIDAR - Bare Earth



RKM 85.5 - 84.8 - LIDAR - Vegetation Height



RKM 85.5 - 84.8 - LIDAR - Vegetation Height



Pre-site Evaluation Form

Date ____________

Location description: ____________

	Likelihood of success			Proximity to existing/restorable habitat				Potential to benefit water temperature	
Location	Depth to water table	available irrigation	in-channel	Existing Riparian	existing/potential side channel	Potential to reduce sediment'	Potential to postively impact groundwater	Exisitng cold water source	

Appendix F. Noxious Weed Prevention Plan

Background

Riparian Restoration and Noxious Weeds

Stream or river banks are riparian areas, and the plants that grow there are called riparian vegetation. Riparian vegetation is extremely important because of the many functions it serves. These are; Flood Control, Wildlife Habitat, Buffering adjacent land uses, Bank Stabilization & erosion control, Shading, providing fish habitat, and supporting the food chain.

For the past twenty years the local community (Scott River Watershed Council, Siskiyou RCD, French Creek WAG, and landowners) have been working to restore and enhance the riparian corridor of the Scott River and key tributaries. The intent of the effort has been to encourage regrowth of key riparian vegetation to support all the key functions of the riparian corridor.

However, it has recently become increasingly clear that management and prevention of the spread of noxious weeds is a key element to the success of any riparian restoration effort. Left unchecked, invasive noxious weeds have the potential to do more harm than the benefit of the restoration project. This document is intended to provide guidance to landowners and groups in the Scott River Watershed to prevent the spread of invasive noxious weeds.

Invasive Weeds:

- Destroy Wildlife Habitat
- Reduce opportunities for hunting, fishing, camping and other recreational activities.
- Displace many Threatened and Endangered Species
- Reduce plant and animal diversity because of weed monocultures-single plant species that over run all others in an area.
- Disrupt water fowl and ne-tropica migratory bird flight patterns and nesting habitats.
- Cost millions of dollars in treatment and loss of productivity to private landowners.

What is a noxious weed?

The term “weed” means different things to different people. In the broadest sense, it it any plant growing where it is not wanted. Weeds can be native or non-native, invasive or non-invasive, and noxious or not noxious. Legally, a noxious weed is any plant designated by a Federal, State or county government as injurious to public health, agriculture, recreation, wildlife or property. (Sheley, Petroff, and Borman 1999) A noxious weed is also commonly defined as a plant that grows out of place. (i.e., a rose can be a weed in a wheat field) and is “competitive, persistent, and pernicious” (James et al 1991)

Common Terms

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Pest: Any organism that directly competes with humans for a desired resource. Pests can be either native or exotic in origin. Plant pests are called **weeds**.

Native: Any species that is indigenous to a given region or ecosystem. In the native range, these species have evolved over millennia with one another, sometimes forming stabilizing relationships like mutualism, competition, predator-prey, or parasitism.

Endemic: species are a subset of native species that are highly unique to a specific geographical location, such as an individual island or mountain.

Exotic: Any species that has expanded its range by overcoming a geographical barrier, such as an ocean or mountain chain. In large part, these range expansions are accomplished only with human assistance. The term doesn't necessarily imply effects on the local community, whether good, bad, or indifferent. For example, honey bees and emerald ash borers are both exotic insects.

Non-native and **introduced** are synonyms.

Invasive species: A small subset of exotic species that are also pests. They tend to dominate communities and landscapes in their new ranges with negative effects to biodiversity, ecosystem functioning, and the local economy. The term **alien** is sometimes used synonymously.

Noxious: Harmful to living things, injurious to health. **Noxious weeds** are designated by federal, state, and county governments as menaces to the public welfare, often with specific regulations on quarantines and requirements to control on private land.

Weeds of concern in Siskiyou County

Weeds of Specific Concern in the Scott River Watershed

Limited distribution weeds:

Orange Hawkweed	*Hieracium aurantiacum*
Myrtle Spurge	*Euphorbia myrsinites*
Purple Starthistle	*Centaurea calcitrapa*
Scotch Thistle	*Onopordum acanthium*
Musk Thistle	*Carduus nutans*
Russian Knapweed	*Acroptilon repens*

Scattered Distribution with potential to become severe problem:

Spotted Knapweed	*Centaurea maculosa*
Diffuse Knapweed	*Centaurea diffusa*
Squarrose knapweed	*Centaurea virgata*
Leafy spurge	*Euphorbia esula*
Perennial pepperweed	*Lepidium latifolium*
Hoary Cress	*Lepidium draba*

Hounds tongue *Cynoglossum officinale*

Wide Distribution*:*

Marlahan Mustard (Dyer's Woad) *Isatis tinctoria*

Canada thistle *Cirsium arvense*

Starthistle *Centaurea solstitialis*

Puncturevine *Tribulus terrestris*

Hemlock

Prevention Measures

- ### Equipment Management
  Power or Pressure wash construction equipment prior to entering relatively noxious weed free, and after leaving infested areas is highly recommended.
- Survey access route for presence of noxious weeds before entering access route. Control noxious weed to the maximum extent possible before entering work site.

Surface Disturbance

- Minimize surface disturbance as much as possible, as this encourages the spread of noxious weeds.
- Re-seed during the first available window of opportunity.
- Certified weed free seed is recommended, and should be required for all grant funded riparian restoration projects.
- Certified weed free straw or hays should be used for mulching.
- If possible, check that gravel and fill comes from a noxious weed free source.
- Plan restoration projects so that noxious weed control is a maintenance component of the project.
- To the extent possible, maintain desireable vegetation at the construction sign to minimize the spread of noxious weeds.

Suggested Grass species for reseeding in the Scott River

Chemical Treatment (Herbides and)

When using any chemical treatment, be sure to follow all labeling. The labeling on herbicides serves as a legally binding agreement.

Non-Residual herbicides- glcycosphate based herbicides are effective for the treatment of some weeds species, especially in the early emergent stages. Glycosphate binds to the soil particiles, so is not residual in the soil and will not kill adjacent vegetation. However, this means it may be necessary to spray more than one during the season. Aquamaster ® and Rodeo® are labeled for use near waterways.

Residual herbicides- Residual herbicides persist in the soil during the entire growing season, and will kill newly emergent seedlings all season long.

Transline- Spotted Knapweed, Puncture Vine

Telar – Marlahan Mustard

Weed inhibitors

Various weed inhibitors are marketed for homeowner use, and can be purchased without a license. These are not for use on crop land, and care should be taken during their application. They can be appropriate to control weed germination in parking and storage areas.

Snapshot,

Resources

http://www.cdfa.ca.gov/plant/ipc/noxweedinfo/noxweedinfo_hp.htm

http://www.oregon.gov/ODA/PLANT/WEEDS/Pages/index.aspx

http://www.calapooia.org/projects/noxious-weed-control-program/